THURSDAY, JANUARY 22, 1885

HIGH-LEVEL METEOROLOGY

Bericht über die Errichtung der Meteorologischen Station auf dem Säntis und ihre Thätigkeit, September 1883 *to August* 1884. Erstattet von R. Billwiller. (Zurich, 1884.)

Journal of the Scottish Meteorological Society. Third Series, No. 1.

WE briefly noticed at the time (NATURE, vol. xxix. p. 413) M. Billwiller's first report on the Swiss high-level station on Säntis, in the Canton of Appenzell; and his second report has now come to hand, giving, along with a rapid history of the establishment of this first-class meteorological observatory and its equipment, an excellent *résumé* of two full years' observations, ending August 31, 1884. A comparison of the results with those obtained for Ben Nevis presents several points of considerable importance.

On Säntis, 8094 feet high, the mean annual atmospheric pressure is 22·237 inches, the highest monthly mean being 22·429 inches in August, and the lowest 21·993 inches in March. On Ben Nevis, 4406 feet high, the mean annual pressure is 25·257 inches, the highest mean being 25·400 inches in July, and the lowest 25·141 inches in January. The differences between the highest and lowest is thus 0·436 and 0·259 inch respectively. On Säntis the mean annual temperature is 28°·2, the highest monthly mean being 41°·4 in August, and the lowest 18°·0 in January. The annual mean for Ben Nevis is 30°·9, the highest monthly mean being 41°·3 in July, and the lowest 22°·0 in February. The lower mean temperature of Säntis is thus wholly due to its colder winters.

But the most marked difference in the climates of the two situations is revealed by the hygrometer. On Säntis the mean annual relative humidity for the two years is 84, the highest monthly mean being 93 in September 1882, and the lowest 71 in March 1884. On Ben Nevis, on the contrary, the lowest mean monthly humidity was 90 for May 1884, and the highest for January of the same year, when the mean dry bulb was 25°·50, and wet bulb 25°·47, showing an approximate humidity of 99. Indeed, so thick and continuous was the covering of mist, fog, and cloud in which Ben Nevis was wrapped during this month, that the difference between the mean coldest and warmest hour of the day in winter is only half a degree. We have drawn attention (vol. xxx. p. 336) to the sudden changes of humidity which characterise the climate of Ben Nevis in connection with anticyclonic movements, when the atmosphere passes rapidly from a state of the most complete saturation to a state of dryness greater than is ever reached at lower levels in this part of Europe, and that on such occasions the temperature rapidly rises, till sometimes it even rises higher than at Fort William, about 4400 feet lower down. Now M. Billwiller gives an extremely valuable column in one of the tables, showing the minimum relative humidity observed each month, from which we see that a humidity of 21 occurred in August 1883, and that on six of the other twenty-three months a humidity less than 30 was recorded. The importance of these observations from Ben Nevis and Säntis on the great movements of the atmosphere in cyclones and anticyclones, and on the Föhn and the various theories that have been suggested in explanation of its phenomena, need not here be insisted on.

On Säntis the annual rainfall, inclusive of melted snow, was 67·83 inches. The heaviest rainfall of any month was 15·12 inches in July 1883, and the lightest 0·71 inch in February of the same year. On the top of Ben Nevis, for the five months from June to October of 1882 and 1883, the mean rainfall was 44·35 inches; and on Säntis, for the same five months of 1883 and 1884, the rainfall was 43·95 inches—the summer rainfall of the two places being thus nearly the same. These amounts are very greatly in excess of what several theories of the distribution of the rainfall on the slopes and tops of mountains would lead us to expect. In discussions of this question it will be necessary to give more pointed attention than has yet been given to the great vertical movements in the atmosphere which are disclosed by the hygrometric observations of these high-level stations.

Of even greater interest are the hourly observations at the two observatories, especially those relating to atmospheric pressure and wind. At the two places the hourly curves of pressure for different seasons run closely parallel to each other. In June, when the more special features of the curves are most pronounced, they closely approximate to a single diurnal minimum and maximum. The minimum occurs from 5 to 6 a.m., and the maximum from 9 to 10 p.m., the daily range being 0·039 inch on Säntis, and 0·030 inch on Ben Nevis. Each curve shows an extremely shallow secondary minimum from 5 to 6 p.m. which, as compared with the secondary maximum immediately preceding indicates a fall not exceeding 0·003 inch.

This secondary maximum occurs at 3 p.m. on Säntis, and at 3.30 p.m. on Ben Nevis, and is the analogue of the morning maximum which occurs at lower levels in the same localities six hours earlier. On Mount Washington, United States, this maximum occurred in June 1873 at 8.30 a.m. at the base of the mountain, 2898 feet above sea-level, 10 a.m. at 4059 feet, 11 a.m. at 5533 feet, and at noon on the top of the mountain at a height of 6285 feet. On Ben Nevis, while pressure is steadily falling at the base of the mountain from 9 a.m. to 4 p.m., on the peak it continues steadily to rise; and the same phenomena doubtless obtain at Säntis.

At the same time the diurnal velocity of the wind on these peaks shows even a stronger contrast when compared with the diurnal velocity at lower levels. At low levels and on plateaux of considerable extent the velocity of the wind falls to the daily minimum early in the morning, and rises to the maximum at or immediately after noon, or about the time of strongest insolation. The following table, showing the diurnal variation in the wind's velocity on Ben Nevis, Säntis, and Mount Washington in summer, and on Ben Nevis in winter, presents for these elevated peaks curves precisely the reverse of the curves for velocity at lower levels. The figures express in percentages the excess or defect of each hour's velocity from the daily mean:—

	Ben Nevis, June—Aug. 1884	Säntis, June—Aug. 1884	Mt. Washington, May—June, 1873	Ben Nevis, Dec.—Feb. 1883—84
1 a.m.	15	18	20	9
2 ,,	15	24	15	7
3 ,,	19	24	9	8
4 ,,	12	16	8	7
5 ,,	7	12	8	3
6 ,,	8	8	1	5
7 ,,	0	4	− 2	3
8 ,,	− 2	− 7	0	1
9 ,,	− 3	− 13	− 8	− 3
10 ,,	− 5	− 15	− 10	− 6
11 ,,	− 11	− 20	− 12	− 8
noon	− 15	− 18	− 19	− 7
1 p.m.	− 11	− 19	− 16	− 7
2 ,,	− 15	− 17	− 12	− 7
3 ,,	− 14	− 11	− 15	− 7
4 ,,	− 10	− 11	− 13	− 7
5 ,,	− 10	− 9	− 7	− 3
6 ,,	− 5	− 8	− 4	− 4
7 ,,	− 3	7	− 1	5
8 ,,	− 0	10	− 3	3
9 ,,	0	5	5	4
10 ,,	9	2	15	8
11 ,,	11	7	19	8
midnight	9	9	19	6

Hence the maximum occurs on these heights shortly after midnight, and the minimum shortly after noon. Now it will be seen that these diurnal maxima and minima occur nearer midnight and noon than do the phases of the other meteorological phenomena, thus suggesting a direct connection with solar and terrestrial radiation. It is singular that, while the diurnal period of strongest insolation determines the occurrence of the maximum velocity of the wind over extensive land surfaces, it determines the minimum velocity on peaks rising to a great height above the land surfaces surrounding them. Of special importance in its bearings on the question is the curve of diurnal variation on Ben Nevis for the three winter months of 1883-84, when the mean velocity of the wind was nearly double that of the summer months. In that season Ben Nevis was under a deep covering of snow, the sky clouded nearly the whole time, the air frequently darkened with dense drifting fogs, and the difference between the mean lowest and highest hourly temperature only half a degree. Notwithstanding the practical uniformity of temperature of the surface of the top of Ben Nevis during the twenty-four hours of the day, the curve of the diurnal variation in the wind's velocity was as clearly marked in winter as in summer, and the two curves were alike in showing the occurrence of the maximum shortly after midnight, and the minimum shortly after noon. We must therefore conclude that the peculiar type of the diurnal curves of wind velocity on these elevated peaks is altogether independent of the temperature of the surfaces over which the winds blow. The results point not obscurely to an investigation of the relations of the visible and invisible vapour of the atmosphere to solar and terrestrial radiation as an inquiry of first importance in meteorology.

OUR BOOK SHELF

Exercises in Electrical and Magnetic Measurement. By R. E. Day, M.A. New Edition. (London: Longmans, Green, and Co., 1884.)

MR. DAY has produced a new and considerably improved edition of a most useful and valuable little book. Every teacher of electricity whose work is not confined to the beggarly elements of mere phenomena will thank Mr. Day for the admirable selection of problems put together in this volume. Nothing could be a greater boon to the real student than the means thus afforded of testing his knowledge of the exact quantitative laws of the science. If it were not for the historic interest of that rather antiquated instrument—the torsion balance—we should doubt the utility of giving so much attention to it. Although the more modern electrometers have entirely superseded the torsion balance as an instrument of research and of measurement, it has, nevertheless, become so prominently fixed—like some grand old fossil long ago extinct—amongst the characteristic forms of electrical instruments, that examiners still expect candidates for examination to know something about it. On the other hand, the space allotted to moments of torsion and inertia is all too brief, though admirably filled. We must, however, take exception to the practice apparently followed on p. 62, of expressing a moment of couple in *dynes:* it should surely be *dyne-centimetres.* The section on the chemical (or rather thermo-chemical) theory of electromotive force is excellent. The problems comprised under the heading Electromagnetic Measurement are admirable, though perhaps a little beyond most students.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Earthquakes and Terrestrial Magnetism

MR. W. H. PREECE having written to the Astronomer-Royal to ask whether any disturbance of our magnets or our earth-current apparatus was experienced during the recent earthquake in Spain, it may be interesting to communicate also for the information of your readers the result of an examination of our photographic registers in consequence made, and especially in order that what has been remarked may, if possible, receive confirmation.

As respects magnetic movement, the magnets on Dec. 25 last and following days were generally quiet. But on looking more closely at the registers, attention was at once drawn to a small simultaneous disturbance of the declination and horizontal force magnets, occurring at 9h. 15m. on the evening of December 25. Both magnets were at this time set into slight vibration, the extent of vibration in the case of declination being about 2′ of arc, and in horizontal force equivalent to ·001 of the whole horizontal force nearly. The movements have not the character of magnetic movements, and, if in reality produced by the earthquake, are of course simply an effect of the shock, the magnets being heavy bars suspended by silk threads some feet in length. About ten minutes afterwards there is doubtful indication in the horizontal force register of a second disturbance. There is no corresponding perceptible disturbance in the earth-current registers.

No other similar motion is observable either on December 25 or on the following days.

It may be remarked that in NATURE for January 1 last (p. 200) the time of occurrence of the earthquake at Madrid is said to be 8h. 53m. p.m. Taking this to be Madrid time, it corresponds to 9h. 8m. of Greenwich time. WILLIAM ELLIS

Royal Observatory, Greenwich, January 15

Teaching Chemistry

THE subject of science-teaching in schools, and more particularly the best way in which practical chemistry should be taught, has of late been discussed in the columns of NATURE. With the editor's leave, I should like to say a little regarding the methods of teaching chemical science in general.

NATURE for January 8 contained notes, by Profs. Sir H. E.

Roscoe and W. J. Russell, on "Experiments suitable for Illustrating Elementary Instruction in Chemistry." These notes appear to me to be very useful as a rough guide to the school-teacher. But unless the teacher is able to arrange the experimental illustrations so that some conclusions regarding the elementary principles of chemistry shall be drawn from the results he obtains, which conclusions shall then be submitted to experimental examination, I think the notes will fail of their object.

It is to the want of progressiveness in the ordinary chemical course that I wish to draw attention.

The student of physics advances; he feels his way from one set of phenomena to another; he generalises, and gets hold of some principles on which he may rest. In the ordinary chemical course the student begins with enthusiasm; he is delighted with the experiments, and he takes a lively interest in the manipulative failures of the lecturer. But, after a little, the student finds that he is not progressing. When he has been told, and shown, the properties of hydrogen, oxygen, and water, he is expected to take as much interest as ever in hearing a list of properties of nitrogen and oxides of nitrogen. Then he fills his note-book with many facts regarding ammonia and nitric acid, and so on.

Now I do firmly believe that chemistry is a branch of science, and that it may be taught as such. I think it is possible, in a course of lectures on chemistry, to lead the fairly intelligent and not very idle student from simple facts about everyday occurrences to the difficult and apparently remote discussions regarding the architecture of molecules, in which chemists so much delight.

If lectures on chemistry were arranged so that principles should be discussed and amply illustrated by well-chosen experiments, instead of being (as I am afraid is still too often the case) repetitions of disconnected facts about a string of elements and compounds, I believe this branch of science would rapidly develop in this country. It seems to me that the distinction implied in the commonly-used terms *chemistry* and *chemical philosophy* is radically unsound. There are not two chemistrys, but one chemistry. We do not speak of physics as different from natural philosophy.

What we want is to convince our students that they are dealing with realities. I am continually presented with answers to questions, which perhaps demand a knowledge of the laws of chemical combination, wherein a few elementary facts are elevated to the rank of an all-embracing theory, and complex structural formulæ are dealt with in a style of appalling familiarity, as if they were the topics which it is necessary to discuss on the very threshold of chemistry. One is told that chlorine is a monad, that is, it is a "one-armed one"; and then the conclusion is triumphantly announced, "*thus we see why it is*" that hydrogen and chlorine combine to form hydrochloric acid, and so on. The other day I implored a candidate in a certain examination to give me a reason for writing the formula of alcohol C_2H_5—OH rather than C_2H_6O; he told me he had seen the former in a book. This is enough for the average student; and yet these people call themselves students of science. I am afraid the teachers are greatly to blame.

The examiners have undoubtedly much power; but I think the examinations in chemistry are improving as a whole.

When a lecturer in chemistry announces two series of lectures, one elementary and one advanced, is it not very often found that the advanced class is condemned to hear copious details regarding the purification and methods of separation of the rare metals, while the elementary class is entertained with an exhibition of the properties and reactions of the simple and compound gases? But is this chemistry?

I think that the teachers of chemistry must consent to abandon the time-honoured practice of placidly proceeding from element to element, and from compound to compound; they must ask themselves whether they know of any reasons why chemistry should be called a branch of natural science, and, having conscientiously answered this question, they must try to make their students really acquainted with these reasons.

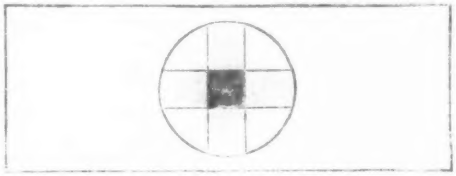
Dr. Sydney Young (NATURE, vol. xxxi., p. 126) has referred to the paucity of good elementary text-books of chemistry. I, too, have felt the want of a really good book in attempting to teach the principles of chemistry to beginners. Is there any elementary book which treats chemistry as a genuine living science? M. M. PATTISON MUIR

Cambridge, January 12

A Method of Isolating Blue Rays for Optical Work

IN many optical experiments, *e.g.* in examining the dispersion of optic axes in crystals, a homogeneous or monochromatic light is required. A fairly homogeneous red light, nearly corresponding to the Fraunhofer line B, can be obtained by a properly-selected piece of red glass placed in front of a good Argand burner or paraffin lamp. For yellow light, nothing can be better than the flame of a Bunsen's burner in which a bead of sodium carbonate is held in a loop of platinum wire. For blue rays, the light transmitted by a solution of cuprammonium sulphate is generally recommended, since the ordinary blue glass coloured with cobalt invariably transmits red rays as well as blue. But the use of a glass cell containing a strong ammoniacal solution is often inconvenient and unpleasant.

I have met with a peculiar kind of greenish-blue glass, used for railway signal lamps, and known as "signal-green glass" (coloured, I believe, with copper in its divalent condition), which is remarkably opaque to the less refrangible rays nearly as far as Fraunhofer's line E, while it transmits a large quantity of blue and some green light. By combining a piece of this glass with a piece of rather deep-tinted cobalt glass, the red rays transmitted by the latter may be wholly stopped, and only the part of the



spectrum between F and G is transmitted, constituting a light at any rate not less homogeneous than that transmitted by solution of cuprammonium sulphate.

This "signal-green glass" is also useful in illustrating selective absorption of light by different media. If, for instance, a piece of it is superposed on a piece of properly-selected red glass, each absorbs what the other transmits, and practically no luminous rays survive the two; only a faint neutral-tinted light struggling through, even when strong sunlight is used.

This can be well shown on the screen by fixing a narrow strip of the "signal-green glass" vertically in a lantern-slide, and crossing it with a similar strip of red glass fixed horizontally in the same frame. The square space where the two overlap appears absolutely black.

The same arrangement is useful for other absorption-experiments, since the original colours of the media are shown, as well as the result of their superposition.

It is necessary to remember that much lighter tints are wanted for lantern-work than for subjective experiments.

Eton College, January 10 H. G. MADAN

Barrenness of the Pampas

IN the admirable address of Prof. Asa Gray at Montreal, he alludes to the singular absence of trees and herbaceous plants throughout the Pampas or vast level plains of the South American continent, and he indorses the opinion of Mr. Darwin and Mr. Ball that this absence is due to the fact that the only country from which they could have been derived could not supply species adapted to the soil and climate. As this is a subject to which I paid considerable attention during a long residence in South America, I venture to call attention to the explanation of this phenomenon, which my observations gave rise to as described in my "Visit to South America," 1878.

The peculiar characteristics of these vast level plains which descend from the Andes to the great river basin in unbroken monotony, are the absence of rivers or water-storage, and the periodical occurrence of droughts, or "seccos," in the summer months. These conditions determine the singular character both of its flora and fauna.

The soil is naturally fertile and favourable for the growth of trees, and they grow luxuriantly wherever they are protected. The Eucalyptus is covering large tracts wherever it is inclosed, and willows, poplars, and the fig, surround every estancia when fenced in.

The open plains are covered with droves of horses and cattle, and overrun by numberless wild rodents, the original tenants of

the Pampas. During the long periods of drought which are so great a scourge to the country, these animals are starved by thousands, destroying, in their efforts to live, every vestige of vegetation. In one of these siccos, at the time of my visit, no less than 50,000 head of oxen and sheep and horses perished from starvation and thirst, after tearing deep out of the soil every trace of vegetation, including the wiry roots of the Pampas grass.

Under such circumstances the existence of an unprotected tree is impossible. The only plants that hold their own, in addition to the indestructible thistles, grasses, and clover, are a little herbaceous oxalis, producing viviparous buds of extraordinary vitality, a few poisonous species, such as the hemlock, and a few tough, thorny, dwarf acacias and wiry rushes, which even a starving rat refuses.

Although the cattle are a modern introduction, the numberless indigenous rodents must always have effectually prevented the introduction of any other species of plants, large tracts are still honeycombed by the ubiquitous biscacho, a gigantic rabbit, and numerous other rodents still exist, including rats and mice, Pampas hares, and the great nutria and carpincho on the river-banks. That the dearth of plants is not due to the unsuitability of the subtropical species of the neighbouring zones, cannot hold good with respect to the fertile valleys of the Andes beyond Mendoza, where a magnificent hardy flora is found. Moreover, the extensive introduction of European plants which has taken place throughout the country has added nothing to the botany of the Pampas beyond a few species that are unassailable by cattle, such as the two species of thistle which are invading large districts, in spite of their constant destruction by the fires which always accompany the siccos. EDWIN CLARK

Marlow, January 15

Japanese Magic Mirrors

IN your last week's issue (p. 249) appears a paragraph from a paper by Dr. H. Muraoka of Tokio on "The Magic Mirror of Japan," and reference is made to the interest these mirrors have excited, and the large number of writers and lecturers who have taken up the subject of their construction. I have read most of what has been written and stated upon the subject, and dissent from all that has come under my notice, especially the ingenious theories of non-continuous convexity of surface. My reason for dissent is that I have seen one, and for some time it was placed in my care by a friend who made it himself in this country.

He, and I have no doubt correctly, assumed that the difference in reflection was due to difference of density, and that by hammering the flat surfaces of the large letters on the back of the mirror, an increased density would be produced which would extend to the front of the mirror, which would then receive a slightly higher polish, sufficient to give the magical figures. From this reasoning he concluded that any metal which could be polished so as to reflect well could be treated in the same way with the same results.

His first experiment was with a half-crown piece, and the success was complete; he had the reverse rubbed down, until a perfectly smooth and polished surface was produced, the reflection from which, on white paper and with a strong light, showed the head of the obverse quite distinctly, but differing from the magic mirrors in this respect, that it was less bright than the other portion of the disk, because the coining-press would bring its greatest pressure upon the field and not upon the type. T. C. A.

Edinburgh

Peculiar Ice-Forms

I INCLOSE a letter with which I have been favoured giving another case of the curious ice-structure lately described in NATURE. The circumstances are very similar to those of the other cases. B. WOODD SMITH

Hampstead, January 16

Regent Road, Leicester, January 13, 1885

DEAR SIR,—Pray excuse my troubling you with an extract from my note-book as to a peculiar form of ice which I saw on the morning of September 21, 1880. I started to descend from the Æggi horn hotel a little before 6, and when I suppose that I was about a thousand feet down, just before coming to the wood, I noticed some curious-looking ice just along the bottom of the sloping sides of the path, which here runs in a shallow gulley two or three feet deep. The ice ran along the side of the path for some yards. I took up several pieces in my hands and examined them, and made a rough sketch, which I reproduce without any additions. The ice was made up of bundles of little rods about one-sixteenth of an inch in diameter and half an inch long. They were roundish and rough or fluted on their sides, and tapered at each end, and in some cases the ends finished with a little thread of ice about a quarter the thickness of the body of the rod. The rods stuck together and were a little curved, and formed roughly two layers, or tiers, one above the other. My note states that these bundles of ice-rods lifted up the dirt and small stones on the top of them. The day before there had been snow with a thaw.

My impression was at the time that water, rising through the ground and being frozen just before it reached the surface, gave rise to these peculiar ice-forms.

You are quite at liberty to make any use you please of this note. I am, dear Sir, yours faithfully,

JOHN D. PAUL

Iridescent Clouds

THE iridescent colours in clouds, observed in England and Scotland in December last, were also visible here December 8, 9, 10, and 12. On the first day, about 3 p.m., the coloured clouds were arranged in a horizontal layer about 20° high, between 20° and 80° azimuth west. In the half altitude a fine stripe broke forth from the background of the ordinary (but not dense) cumulo-stratus.

The opinion of one of your correspondents that a connection exists between this and the sky-glows of the last two years, is contradicted by the circumstance that the phenomenon has been observed here several times before, viz. 1871, February 22, March 1, May 10; 1874, January 13; 1875, February 17; 1881, December 27; 1882, January 11, February 22, July 13. I make the following extract from the observation of 1882, January 11, showing the peculiar changes in the colours:—at 3.30 p.m. (sun set at 3.20) extremely beautiful iridescent cirro-stratus in south-west, in an altitude of 8°—12°. The upper borders, later also the lower, were red, with yellow brims, the rest of the borders and the inner parts very variegated and variable; the light red, commonly seen in mother-of-pearl, changed through crimson into blue-green, and then into grass-green. On some spots this change was repeated twice. The variation of the colours continued till after 4 o'clock; at 4.30 the colour was the ordinary red. The form of the clouds varied very slowly.

1881, December 27, an isolated brilliantly-coloured cloud was observed through two hours at least. A drawing of it by Dr. Reusch (in woodcut) is inserted in the Norwegian *Naturen* 1882, No. 1.

The most striking cases of this phenomenon have been observed here when mild and dry weather set in after frost.

H. GEELMUYDEN

University Observatory, Christiania, January 11

Solar Phenomenon

AS I see no record of what I witnessed on the afternoon of the 14th instant in NATURE of the 15th, I trouble you with this brief statement. At 3h. 20m. p.m. on that day I was struck by the appearance of the sun, which was crossed by a light stratus cloud of a clearly-defined outline, below which appeared what seemed a column of light of uniform width, down to the horizon, the width being somewhat less than the sun's diameter. By 3h. 30m. the definition of this parallel beam was less marked, but the sun presented to me the appearance of an oblong, suggesting three partially-superposed disks. Soon afterwards the sun was wholly obscured. The day had been cold, the temperature being never far from freezing-point in the shade. I have on former occasions, and in summer, seen the parallel beam striking upwards, once in association with a mock sun.

Valentines, Ilford C. M. INGLEBY

A Cannibal Snake

WITH reference to notes as to Ophiophagous snakes, which appeared at pp. 216, 269, 312, and 408 of the last volume of NATURE, I inclose a communication received by me this morn-

ing from Borneo. The habit seems general, and, according to the above letters, not confined to venomous or non-venomous varieties. EDWARD F. TAYLOR

St. Augustine's College, Canterbury, January 13

"*Sarawak, Borneo, November* 11, 1884

"The inclosed cutting from NATURE was sent me by H. Brooke Low, Esq., resident of Rejang, with a desire that I should forward my experience (which was similar to Mr. Evans's) to your paper. A young Dyak youth was walking up the hill towards my house, when a snake sprang out of the bank and fastened itself on the boy's jacket, just under the right arm. Fortunately, its fangs got caught in the cloth, and the boy escaped unhurt. Eventually, the reptile was killed and brought to the house. It measured five feet and some odd inches in length. In examining its fangs I noticed in its mouth the tail of another snake, and, on pulling it out and comparing them, I found it to be a few inches *longer* than the outside snake, though not quite so thick. I have come to the conclusion that this snake is the *Ophiophagus elaps* of the Straits. The native name for it is 'Ular Kendawang.' It is more deadly, more agile, and more beautifully marked than the 'Ular biliong' mentioned by Mr. Evans. So fascinatingly beautiful is the appearance of this snake, that in Dyak poetry one of their heroes is described as 'Crowned with the cast skin of the Ular Kendawang,' thus attributing to the hero that comeliness, agility, and fearlessness for which the 'Kendawang' is noted. I have reason to believe that the 'Ular biliong,' or axe snake (from the shape of its head), mentioned by Mr. Evans is an Ophiophagus, but it is not what is called the 'Elaps.' Its movements are sluggish, and its poison is not nearly so deadly as that of the 'Kendawang.' The distinctive marks of the 'Kendawang' are a reddish head and tail, the red of the tail being about twice the length of the head. The ground colour of the body is generally of a dark gray, but I have seen them of a silver gray, and also dark brown. A light streak of flesh-colour runs down the back, and the edges of it are serrated with vermilion and metallic-green spots, with just enough of white and yellow to make a most pleasing combination of colour. Besides these two, there are two other species belonging to the Ophiophagous class. The native names are 'Kengkang mas,' or 'Tinchin mas,' *i.e.* golden-ringed; and 'Matikor,' *i.e.* dead-tailed, and these four species are, I believe, very common throughout the Malay Archipelago. "M. J. BYWATER,

"S.P.G. Missionary in Sarawak"

The Canadian Geological Survey

A PHRASE used in your condensed report of my remarks after Sir J. H. Lefroy's paper, read on January 13 at the Colonial Institute, may, I fear, be misunderstood by some of my friends in Canada. I am reported speaking of the Geological Survey of that country as "being slowly conducted." My remarks were not intended to imply the slightest reproach. I explained that progress could not be rapid because of the vast extent of the territory and the natural difficulties of many parts of it. I think, indeed, that it is surprising that, having regard to the means at their disposal, the Survey have accomplished so much. I urged that, as it was impossible for the present staff to prospect specially for minerals without abandoning the general work of surveying, which is of the more importance for science, some specialist should be added to it, to whom the former duty should be assigned. I did not use quite so strong a phrase as that I "*believed* the district north of the St. Lawrence was rich in valuable minerals." My opinion is that, as certain parts are known to be rich, and as there is great uniformity in the geology of the district, it is very probable similar deposits exist in the (very large) unexplored portion. T. G. BONNEY

23, Denning Road, Hampstead, N.W., January 19

ASTRONOMICAL PHENOMENA FOR THE WEEK

1885, JANUARY 25-31

(AS an experiment we have here adopted for the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24.)

At Greenwich on January 25

Sun rises 7h. 50m.; souths 12h. 12m. 40.9s.; sets 16h. 35m.: Decl. on meridian 18° 50′ S.; sidereal time at sunset 0h. 55m.

Moon (1 day past First Quarter) rises 11h. 55m; souths 19h. 29m.; sets 3h. 12m.*; decl. on meridian 15° 59′ N.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury ...	6 23 ...	10 27 ...	14 31 ...	21 47 S.
Venus ...	6 31 ...	10 29 ..	14 27 ...	22 44 S.
Mars ...	8 6 ...	12 29 ...	16 52 ...	18 54 S.
Jupiter ...	19 6* ...	2 7 ...	9 8 ...	11 10 N.
Saturn ...	12 43 ...	20 46 ...	4 49* ...	21 32 N.

January 26, 16h.—Mercury at greatest elongation from the Sun, 25° W.

Occultations of Stars by the Moon

Jan.	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to left
			h. m.	h. m.	° °
26 ...	B.A.C. 1526 ...	6 ...	19 13 ...	19 49 ...	19 328
27 ...	B.A.C. 1930 ...	6½ ...	20 38 ..	21 30 ...	33 316
29 ...	λ Geminorum ...	3½ ...	2 23 ...	3 21 ...	132 284
30 ...	B.A.C. 3122 ...	6½ ...	20 54 ...	21 59 ...	30 237
31 ...	π Leonis ...	... 5 ...	17 53 ...	18 35 ...	5 255

Phenomena of Jupiter's Satellites

Jan.	h. m.		Jan.	h. m.	
25 ...	4 1	I. tr. ing.	27 ...	0 47	I. tr. egr.
	6 21	I. tr. egr.		19 8	I. ecl. disap.
	21 40	IV. tr. egr.		21 33	II. ecl. disap.
26 ...	0 40	I. ecl. disap.		21 58	I. occ. reap.
	3 31	I. occ. reap.	28 ...	1 33	II. occ. reap.
	3 52	II. tr. ing.		19 13	I. tr. egr.
	6 47	II. tr. egr.	29 ...	19 54	II. tr. egr.
	7 27	III. ecl. disap.		23 19	III. tr. ing.
	22 28	I. tr. ing.	30 ...	2 54	III. tr. egr.

* Indicates that the rising is that of the preceding, and the setting that of the following nominal day.

DUST[1]

MY business this evening is to talk about dust: meaning by dust all suspended foreign matter of whatever kind, and including smoke and fog under the one heading. Coming from England I should naturally begin by saying, well, we all know what dust and smoke are; and even in Canada, I suppose, I may venture to say the same, though I am bound to say that your country, at present, shows a remarkable deficiency in this respect. In an English town dust and smoke are the most noticeable features, and are always ready to perform any insanitary or other function that may be expected of them. In this clear atmosphere none of these functions can be properly performed; disease-germs must languish and die, and their sworn foes, the white corpuscles of the human blood, must thrive amain. Let me say, however, that the air here is not so absolutely free from smoke as I had hoped to find it. Compared with an English town it is a splendid contrast; compared with one's ideal it falls short. Your houses may indeed burn anthracite and wood, but your passenger locomotives do not: I can attest from very recent personal experience, in a journey across this continent, that some of your locomotives emit almost as much smoke as a Clyde steamer, and that the journey would have been much pleasanter if they had emitted less. I also see some factory chimneys rising here and there. If you be not warned in time, you will not realise the blessing of fresh and pure air until you have lost it. It is good to have large manufactures, it is better to retain healthy and pure air. But with proper care the two may go together. Once lose ground in this respect, as we have done in

[1] Evening discourse to the British Association at Montreal, on Friday August 29, 1884, by Oliver J. Lodge, Professor of Physics in University College, Liverpool

England, and terribly uphill will be the retracement of your steps. The old country has in many things made experiments for you—experiments of which you may reap the benefit, without repeating them, if you choose. The experiment of Protection, which we have tried and abandoned, I dare not here mention except just by name; but I dare mention the experiment we have tried only too successfully, and by no means yet abandoned though we groan under it—that of fouling the atmosphere, wherever a large number of human beings have to live in it, to such an extent that it is not fit to breathe. We have made a terrible mistake, and one that will take perhaps a century to undo. Tax all the necessaries of life and it is a small evil, for the tax may at any time by an Act of Parliament be removed, but pollute the air in which a people have to live and no one can see the end of the evil. You will soon have towns here rivalling Liverpool and Glasgow and Manchester in size, and some day London. Be warned in time.

However, in speaking of dust, I am not going to confine myself to such artificial dust as is made in towns, I shall include everything which Tyndall means when he calls it "the floating matter of the air," all diffused and floating foreign matter, fine or coarse. But the term "floating" is not free from possible misconception, and a better term than floating is sinking. If the two sound antagonistic, then floating was wrong. Foreign particles, whether solid or liquid, are not floating, and cannot float, in air; they are all necessarily sinking through it, and sinking at a well-defined and fairly calculable rate. Consider, for instance, the water globules of a fog, or mist, or cloud. The drops of water appear to float in air, but they are not floating, they are slowly settling down. They may in truth be buoyed up by convection currents, but they never move up *through* the air, they move up *with* the air to some extent, but are always slowly falling through it whether the air be moving or stationary. Are they then like a slowly-falling balloon or soap-bubble? No, they are not buoyed up at all—they are falling as fast as ever they can. Water is 800 times as heavy as air, and a drop of water falls under the influence of this enormous difference in weight. Why does it not fall faster? Just for the same reason as prevents an Atlantic liner from being propelled at 50 knots an hour—skin friction. A ship requires a great force to propel it at 15 knots an hour; break it up into small pieces and it will take vastly more; pound it into infinitely fine dust and it will require an infinite force to propel it at any slow pace. I do not say that a small body as it moves through a fluid experiences more resistance than a large one—it experiences less; but the decrease of resistance is not so rapid as the decrease of its bulk or weight, and consequently a small falling body is resisted more *in proportion to its weight* than a large one. Consider a bullet or a raindrop falling from a great height. As it falls it keeps moving quicker and quicker, but not without limit. Its weight remains constant, the resistance it meets with increases with its speed; hence there comes a time when the two balance and the body is in equilibrium. It then ceases to gain speed: it has attained its "terminal velocity." Even if thrown down faster than this it would slacken till it attained it. Now this terminal velocity is greater for a bullet than for a small shot, is greater for a large raindrop than for a small one, and for a mist globule is very small. The old idea concerning cloud globules, that they were hollow vesicles and therefore floated, is quite erroneous. They do not float, they sink. Slowly sinking particles, then, constitute dust, whether these particles be solid or liquid. Water dust is so important that it has various names, such as mist, fog, rain, cloud, and, in popular usage, steam.

Having now stated what dust is, the question presents itself, How did it get there? What are the sources of dust? There are certain human sources of dust—such as the traffic of towns, and the smoke of imperfect combustion. These produce coarse and heavy particles which never rise to a great height, nor float very far from their source: this dust may be regarded as mere dirt and filth. Besides this, however, a fine impalpable dust is produced by every terrestrial activity. The wind blowing through trees, the waves tossing up spray—all these natural activities disperse into the air very fine particles, which are upborne and carried so far from their source that they form quite a permanent part of the atmosphere. This fine natural dust is not limited to the lower atmospheric levels, but is almost equally abundant at great heights; to it we owe the blueness of the sky, and by it clouds and mists are rendered possible.

Another source of dust is found in volcanoes. During an eruption immense torrents of pumice and ashes are driven upwards to incredible heights, whence they slowly settle down again, the larger fragments sometimes covering the sea for acres with a thick floating deposit through which steamers slowly crunch their way, almost as if steering through land (see a graphic account in NATURE, signed Stanley M. Rendall, forwarded by Prof. Turner, vol. xxx. p. 288, July 24, 1884; see also vol. xxix. p. 375, abstract of paper by Capt. Vereker); the finer particles being carried hundreds of miles away from their source, and giving rise to brilliant appearances as they catch the solar rays—appearances recently observed over a great part of the world at sunset.

Yet another variety of dust is that which comes to us from ultra-terrestrial sources, fragments of interplanetary matter, cosmic or meteoric dust. You all know of the showers of falling stones—the August and November meteors; you know that these are lumps of interplanetary matter careering through space, mostly doubtless round the sun, but not aggregated together into planets. Cold lumps of iron they mostly seem to be, possibly fragments of some ancient world, possibly relics of the old nebulous world material, never yet aggregated into worlds at all. For ages they may have been rushing along, some almost isolated, others crowded together, and so they might rush on for millions of years; but a larger body bears down upon some of them; they feel the gravitative influence of the huge mass of a planet; they are deflected from their course notwithstanding their prodigious speed, and a few dip into its atmosphere. In an instant the terrific friction strips off their outer coat, scrapes and rubs the surface till it glows with a white heat; streams of white-hot particles are still scraped off, and form a luminous trail, but the white-hot masses plunge on: and one perhaps escapes to resume its wanderings, disturbed a little by its encounter but not destroyed; another may be rubbed to fragments altogether; another may be heated so rapidly and unequally as to explode; while another may enter the atmosphere at a more moderate velocity—may be heated indeed, and violently scraped, but not destroyed, and may embed itself in the ground, to be dug up by some peasant as a thunderbolt and to be preserved in some museum. The frayed particles of such meteors must constitute no inconsiderable portion of terrestrial dust; and since it comes from altogether extra-terrestrial sources, it is to us of most intense interest. One other visitant from other worlds we know of, and that is light. Light is found to be charged with information, though it took man many centuries to learn how to read it—first with the telescope, now with the spectroscope, and next with who shall say what still more potent revealer and analyser of hidden truth. Meteoric dust may not be so laden with information as light is—certainly we have not yet learnt to read it. It is only within the last few years that, at the instigation of Sir William Thomson, a Committee of Section A of the British Association was appointed to consider the question whether such dust could be collected and detected at all. Under the able and energetic guidance of Dr. Schuster, this Committee has done good work, and some dust from the ice-fields of the Himalayas

and from Greenland has been definitely proved to be meteoric.

At present however no sign of organic matter or evidence of extra-terrestrial life has yet been detected in it, but any year this statement may have to be modified, and a discovery of the most intense interest may have to be announced. You have probably all heard of this theory of Sir William Thomson's, that some life germs may have been carried to the earth by a meteor, and you are probably equally well acquainted with the cheap ridicule the statement met with at the hands of newspaper article writers and the general public. It was derided as an absurd attempt to explain the origin of life. It was nothing of the kind. Nothing at all was said about the origin of life; it was a sober matter-of-fact statement that it was a scientific possibility for some organic germs or seeds to be conveyed to the earth by a meteor, to be rubbed off it at its first entrance into the atmosphere without getting overheated, and thence to slowly settle down as dust, and germinate. Well, it is a possibility, and it may before now have happened, and it may happen again, and very interesting it would be to be able to point to a case of its happening. But what then? If you account for the presence of a cherry-tree in your orchard by saying that it sprang from a cherry-stone dropped by a passing balloon, are you to be assailed as a full-blown explainer of the origin of all cherry-trees and of all forms of life?

You may take it as a fairly safe rule that when a statement is made by the highest living scientific authority, the statement may or may not be true, but it is not likely to be such abject nonsense that any newspaper article writer, in the interval between ten o'clock and midnight, can see all through it, detect its follies, and serve them up exposed for your breakfast edification.

Leaving the subject of meteoric dust now, and of the possibility of future discovery which may be wrapped up in it, let us proceed to ask, What is dust for—what purpose does it serve? We shall not enter upon the teleological inquiry, what was it intended to do; we shall simply ask what it does—a plainer, and for the most part a more instructive, question.

First, what is the function of human dust, such as is made in towns? One of its functions is to choke up the breathing organs both of plants and animals; another is to propagate disease from place to place. It is one of the most important discoveries of this century, that infectious disease is due to the growth of a specific vegetable organism in the system, propagating itself like yeast in dough, or ferments in alcoholic liquors. The germs of these organisms float about in the air from place to place, and gain positions enabling them to enter the blood of some animal organism, say man, where they can grow and flourish, provided they are able to successfully encounter their mortal foes, the white corpuscles of the blood. If these white corpuscles are strong and vigorous, they will overpower the foreign growth, and kill it. If, on the other hand, they are weak and feeble, and the germs are very numerous, the foreign growth may get a secure footing and spread luxuriantly, changing the character of the fluids of the body, coagulating, it may be, the albumen, and otherwise setting up the unnatural and abnormal display of functions which we call disease. I have only to indicate thus much to exhibit to you the enormous field of knowledge and of inquiry which is involved in the discussion of the function of dust from this point of view.

But it is not my province to discuss this, and I must hasten on to more purely physical considerations, and must ask, What is the function of the fine impalpable dust or ultra-microscopic particles in the upper regions of the air? First of all, it is this which causes the blue of the sky and the diffusedness of daylight. I have not time to go into this. I will only state it, and pass on. You will find the rudiments of it beautifully expressed by Dr. Tyndall in his Lectures on Light, but it will take Lord Rayleigh to explain it to you completely.[1]

If the atmosphere were purely gaseous, and held no minute foreign bodies in suspension, the aspect of the sky would be utterly different from what it now is. The sun would glare down directly with blinding intensity, and objects not in direct sunlight would be in almost complete shadow. A room facing north would be in something like darkness: at least, it would be only illuminated by reflection from illuminated objects outside. The sun would be set in a black firmament, and if its direct light were screened off it would be easy to see the stars at noonday. (Through dust-free air light passes on without loss by scattering, and is quite invisible except to any eye placed directly in its course. [Tyndall's optically empty tube was here shown.] There is nothing remarkable in seeing nothing, when no dust or other reflecting body is present. When you see motes dancing in a sunbeam, it is not the motes which render the sunbeam visible, but the sunbeam the motes; and of course light is invisible which does not enter the eye.)

What is the actual state of things as contrasted with this? The sun's rays on reaching our atmosphere are partially intercepted, diffused, and scattered by myriads of most minute particles, so minute as to be even smaller than the light-waves themselves, and to act on the smallest of these waves more powerfully than on the largest. The light thus scattered is the diffuse daylight so entirely satisfactory and pleasant to the eye, and so inimitable by artificial systems of illumination. The light thus scattered has a preponderance of small waves, owing to the minute size of the scattering particles, and hence it affects our sight organ with the sensation of blue. By this scattered light shadows are mellowed, the intensity of direct sunlight is mitigated, and the whole expanse of sky glows with a perfect lustre, effectually drowning the light from the more distant celestial bodies. Above the top of a high mountain dust is almost absent, and there the sky has been observed at times to look almost black, and stars are sometimes visible in sunlight.

But besides the blue of the sky, we owe to this dust the possibility of clouds, which still further intercept and scatter the solar beams. "Cloud is visible vapour of water floating at a certain height in the air," says Mr. Ruskin[2]; but he is not quite right in his language. True vapour of water is invisible, and that which is visible is no longer vapour, but condensed vapour. It is vapour which has condensed to liquid—not to great masses of liquid, but to minute globules or spherules of liquid, so small as only to sink very slowly through the air. What makes the vapour condense into this water-dust form? Why does it not condense at once into great masses or sheets of water? Something there must be to start the condensation at multitudes of separate points, so that the vapour shall condense the instant it is saturated, without ever becoming supersaturated. Things that act in this way are called nuclei. Without a nucleus, it is as easy for a phenomenon to begin at one place as at another, and when that is the case it does not begin anywhere: there is no preponderating cause. Wherever there is a nucleus, however, there the action can begin; and in order that action may commence at an infinity of points at once, it is necessary that an infinity of nuclei exist. The action of nuclei is readily illustrated by the well-known experiment of a supersaturated solution of Glauber's salts. The solution remains liquid until a nucleus is introduced, when it becomes suddenly converted into a solid. (I don't say that it is clear *why* nuclei are able to start the action. What is there at the surface of discontinuity to make change of state easier there than anywhere else? It will take a bigger man than me to tell you that.[3])

[1] *Phil. Mag.*, August 1881. [2] "Storm Cloud" lecture, p. 12.
[3] Sir W. Thomson has partially indicated a reason for it in his theory of the effect of curvature of surface on vapour-tension. See Maxwell's "Heat," chap. xx. p. 268.

Now this sudden conversion is just what might happen in the case of the atmosphere, only the change of state would be from vapour to liquid. Picture to yourselves aqueous vapour accumulating and increasing in quantity in dust-free air, saturated, over-saturated, nothing to start the condensation; it goes on accumulating; the atmosphere becomes unbearably damp, soaking into and through everything. At length at some point something causes it to give way, and condensation takes place. Instantly it spreads from this point as from a centre, volumes of liquid are produced, and fall not as a shower but as a splash, deadly and destructive by the mere weight and impetus of its fall.

Instead of this, what really happens? The moisture, on becoming saturated, finds myriads of minute dust particles or nuclei, round which it condenses; the more numerous the nuclei, the more minute may be the globules of mist formed; it never becomes supersaturated at all. The instant it is saturated it begins to condense, and we have the mist or visible cloud, and in this form it may last for any length of time. Under certain influences, however, not yet fully understood, but which I wish in part to illustrate to-day, these minute globules may congregate into larger ones. Too large to remain slowly falling through the air, they begin to fall more quickly as their size increases, and we get the fine shower; or, if the aggregation goes on further, and the drops do not evaporate much as they fall, we have the heavy downpour, the thunderstorm, or the tropical deluge—all varieties of rainfall caused by the different size of the aggregated water globules.

Were there no nuclei, condensation would not begin, and were there but few nuclei, condensation could only begin at a few points, and a quite different kind of mist might present itself; one which would consist of comparatively large and rapidly sinking globules—small for raindrops, but large for mist globules, a kind intermediate between mist and rain, such a mist as is met with in clear moist climates, and known in England as a Scotch mist.

Note this, that to get a fine permanent fog, you must have an enormous number of centres of condensation. Mr. Aitken (*Trans. Roy. Soc. Edin.*, about 1879) established this fact, that every spherule of mist must have condensed itself round a minute solid dust particle, a nucleus, and that without such nuclei condensation could not go on. The minuteness of the nuclei able to act in this way is extreme, an almost immeasurably small quantity of matter being sufficient to precipitate a copious cloud. Their size is quite beyond a microscope.

[Mr. Aitken's experiment was here shown with apparatus from the Royal Institution. A long glass tube is filled with moist air, carefully filtered through cotton wool and glycerine, after Tyndall, and is then suddenly exhausted by an air-pump. It is thus cooled far below the dew point, but no precipitation occurs; and the tube, well illuminated, is seen to remain clear. Now ignite a platinum wire inside it with a few Grove cells, and let more filtered air enter. As soon as this is done exhaust again; instantly a thick cloud is precipitated, condensation occurring round myriads of nuclei given off from the platinum wire—which, however, has not appreciably lost weight. I wonder if this experiment could not give Sir Wm. Thomson a fifth limit to the size of atoms by estimating the loss of weight of the platinum spiral and the number of globules in the resulting mist.]

A familiar illustration of the effect of nuclei on vapour is given by the simple experiment of writing on a pane of glass with a stick, and then breathing on it. Where the writing has wiped away the dust, the moisture condenses less easily and in much fewer and larger globules than where nuclei are abundant; consequently the writing becomes visible.

In studying the properties of any physical agent, it is essential to be able to employ it or exclude it at pleasure. One must have insulators to investigate electricity; one must perform optical experiments in a dark room; and to study the properties and functions of dust it is important to be able to remove it, and to obtain dust-free spaces.

Methods of removing dust from air are:—

(1) Filtration through cotton-wool, or cotton-wool and glycerine, packed tightly. Tyndall has shown how effective this can be made with proper management.

(2) Allowing it to settle. In a few days or a week most of the dust has settled out of stagnant air. Prof. Noel Hartley employed atmospheres of hydrogen in his old and careful experiments on "spontaneous generation," because it was too rare for germs to float in.

(3) Condensing vapour in the air several times. Mr. Aitken has shown that successive condensations of vapour gradually purify air by removal of nuclei, until it is quite clear. He shows that the ability of vapour to condense is an extremely delicate test of the presence of such nuclei, and that when the dust particles are very few, condensation takes place not as cloud but as fine rain or Scotch mist. Doubtless, the cause of actual Scotch mist is the clearness and purity of the Highland air induced by frequent and continued rains.

(4) Keeping a hot body in air for some time. This, Tyndall calls "calcining" the air.

(5) Discharging electricity into it from a point.

I must say a few words about the two last methods. When a hot body is held under a sunbeam, a dark stream of dust-free air is seen rising above it. This was discovered by Dr. Tyndall, and investigated by Lord Rayleigh, as well as by Mr. Clark and myself.[1] A hot spiral of platinum wire in a bell-jar produces this dust-free stream, and so gradually clarifies the air in the jar. That this is not due to combustion or evaporation we proved by using the smoke of burnt magnesium, which answers perfectly. Lord Rayleigh has shown that a cold body is similarly effective, and causes a *descending* dust-free stream.

We have found that the dust-free streamer is only a prolongation of a dust-free *coat* which surrounds all warm bodies. The dust is kept away from them by molecular bombardment. It has been shown by Tait and Dewar, and by Osborne Reynolds, that a Crookes bombardment is effective at even ordinary pressures provided the bodies bombarded are small. Dust particles are very small, and so they get driven by molecular impact away from hot surfaces and towards cold ones: the distance through which they are so driven away being easily measured by observing the thickness of the dust-free coat round an illuminated body at known temperature.[2] Two black tin vessels or glass flasks can be put under a bell-jar, one of the flasks full of warm water, the other of cold. On now burning magnesium, or otherwise filling the jar with smoke, the cold one will presently be found thickly covered with a deposit, the warm one will be nearly free. What Tyndall calls "calcining" the air, then, is really bombarding the dust out of it on to the cool wall surfaces. The deposition of lamp-black on a cold body held in a flame is thus explained. Whenever the air is warmer than bodies it deposits its dust and smoke upon them; whenever bodies are warmer than the air they keep the dust off, except when the weight of some of the larger particles is sufficient to overcome the bombardment; a thing which is very likely to happen on a horizontal and slightly warm surface.

[1] Mr. Aitken commenced the same investigation after reading my preliminary note of July 1883 in NATURE, and has followed it up in much the same way as we have, obtaining very similar results. I have just seen Mr. Aitken's paper in the *Trans. Roy. Soc. Edin.*, vol. xxxii. Part II. He therein criticises one or two of the views I somewhat hastily expressed in the preliminary note referred to. But our views were naturally modified by further experience, and in the complete paper in the *Phil. Mag.*, March 1884, they are more carefully expressed. It would have been better if I had not written to NATURE until the investigation was complete.

[2] See Lodge and Clark, *Phil. Mag.*, March 1884; also NATURE, July 26, 1883, vol. xxviii. p. 297, and April 24, 1884, vol. xxix. p. 612.

So we learn that the things in a room warmed by radiation (sunlight or open fire), because they are warmer than the air of the room, do not tend to get very dusty. But in a room warmed by hot piping or stoves, things are liable to get very dusty because the air is warmer than they are.

Finally, let us turn to electrical phenomena in dusty air. Just as a magnet polarises iron filings, and makes them attract each other and point out the lines of force, so an electrified body polarises dust particles, and makes them point out the lines of electrostatic force. It is therefore very interesting to watch electrical phenomena in illuminated smoky air.

The pyroelectric behaviour of tourmaline for instance is beautifully shown by the aggregation of dust in little bushes at the opposite poles of the crystal. Mica often exhibits strong electrical actions. But perhaps the most curious thing of all is what happens when a brush discharge begins in such air. The violent and tumultuous action must be witnessed—it can hardly be described; but it does not last long, for in a few seconds every particle of dust has disappeared, condensed on the walls and floor of the vessel.

[An experiment of discharging from a point connected with one pole of a Voss machine into a bell-jar of illuminated magnesium smoke was then shown. It is a very easy experiment, and rather a striking one. A potential able to give quarter-inch or even one-tenth-inch spark is ample, and better than a higher one. The smoke particles very quickly aggregate into long filaments which point along the lines of force, and which drop by their own weight when the electrification is removed. A higher potential tears them asunder and drives them against the sides of the jar. A knob polarises the particles as well as a point, but does not clear the air of them so soon. If the bell-jar be filled with steam, electrification rapidly aggregates the globules into Scotch mist and fine rain.[1]]

This experiment shows how quickly air may be cleared of its solid constituents by a continuous electrical discharge. The fact may perhaps admit of practical application in clearing smoke-rooms, or disinfecting hospital air. It also must have a close bearing on the way in which "thunder clears the air," on thunder-showers, and perhaps on rain in general. Sir Wm. Thomson's "effect of curvature on vapour-tension" shows that large cloud globules increase at the expense of small ones, and so may gradually grow into raindrops; but under electrical influence rapid aggregation of drops mu-t occur. The large drops so formed may be upheld by the electrical attraction of a strongly charged thunder-cloud, but as soon as the flash occurs, down they must come. Lord Rayleigh made some interesting observations on the effect of a feeble electrical charge in inducing a spreading water-jet to gather itself together (*Proc. Roy. Soc.*, No. 221, 1882); and Prof. Tait has pointed out in his lecture on Thunderstorms (NATURE, vol. xxii. pp. 339, 436) that aggregation of feebly charged drops into larger ones is of itself sufficient to raise their potential. One strongly charged cloud would thus act on another, aggregating its drops, and so raising its potential until a flash is a necessity.[2]

It seems not impossible that some use may be made of this aggregating power of electricity on small bodies, such as smoke particles and mist globules. In coming to this country we lay for some hours outside the Straits of Belle Isle in the midst of icebergs mingled with fog. Icebergs alone are not dangerous but beautiful. Fog is an unmitigated nuisance. Electric light is powerless to penetrate it; and it was impossible, as we lay there idle, not to be struck with the advisability of dissipating it. It is rash to predict what can be done, it is still rasher to predict what can not. I would merely point out that on board a steamer are donkey-engines, and that these engines can drive a very powerful Holtz or Wimshurst machine, one pole of which may be led to points on the masts. When electricity is discharged into fog on a small scale, it coagulates into globules and falls as rain—perhaps it will on a large scale too. Oil stills the ripples of a pond, and it has an effect on ocean billows; just so an electric discharge, which certainly coagulates and precipitates smoke or steam in a bell-jar, may possibly have an effect on an Atlantic fog. I am not too sanguine, but it would not cost much to try, and even if it only kept a fairly clear space near the ship, it would be useful. There are other possible applications of this electrical clearing or deposition of dust, but I am not here to talk of practical applications but of science itself. A homely proverb may be paraphrased into a useful motto for young investigators. Stick to the pure science and the applications will take care of themselves. I am not one to decry the applications of science for the benefit of mankind, far from it, but while the rewards of industrial applications are obvious and material, and such as will always secure an adequate following, the rewards of the pursuit of science for its own sake are transcendental and immaterial, and not to be imagined except by the few called to the work. That call entails labour and self-sacrifice beyond most other, but they who receive it will neglect it at their peril.

[1] I find that unless one claims a lecture experiment it is commonly treated as a *rechauffée*. It is pardonable, therefore, and indeed only due to Mr. Clark, who has been associated with me in the dust research, to state that these observations are original. A small cellar can be cleared of thick turpentine smoke pretty quickly by a point discharge.

[2] If the initial potential of the second cloud were opposite to that of the first, the spark would pass between the two clouds: if it were similar, its rise would raise the potential of the first cloud, and so cause it to spark into something else.

HEREDITARY DEAFNESS[1]

THE startling title of Mr. Graham Bell's admirable memoir is fully justified by its contents. It appears that there are upwards of 33,000 deaf mutes in America, mostly collected in large institutions forming social worlds of their own, whose inmates intermarry or else contract marriages with the hearing relatives of their fellow pupils, who themselves, in many cases, must have an hereditary though latent tendency to deafness. This state of things has been going on increasingly for two or more generations, with the result that congenital deafness, which in other countries appears sporadically, and mostly fails to obtain an hereditary footing, has become artificially preserved in America, and is intensified by inter-marriages, until a deaf variety of the human race may be said to be established. There can be no question, after reading the mass of evidence submitted by Mr. Graham Bell, of the general truth of this summary statement. That precise knowledge that we should be glad to possess, of the strength and peculiarity of the hereditary taint, is unfortunately unattainable owing to the imperfection of the records kept at the institutions of the after history of their pupils; but the data, such as they are, have been handled with great statistical skill by the author, so that he has squeezed all the information out of them that they appear competent to give.

We may now go a little more into details. It appears that out of six asylums, with an aggregate of 5823 pupils, 29·5 per cent. have deaf relatives. Also that nearly half the pupils contract marriages, and that 80 per cent. of those who do so, marry together. This ratio of intermarriage is much greater than it was at the beginning of the century, and it appears to have steadily increased from then up to the present time. It is unfortunate that the imperfection of the records kept at the institutions make it difficult to ascertain the exact rate of the increase or the precise fate of the issue of all the marriages. This latter fact may, however, be estimated by working back-

[1] "Upon the Formation of a Deaf Variety of the Human Race," by Alexander Graham Bell, National Academy of Sciences, New Haven, U.S.A., November 13, 1883.

wards, and finding the number of deaf-mutes known to exist among the ancestors of the present inmates of the asylums. The family history of many of these is appalling, such as "Grandfather, father, mother, and other relatives"; "father, mother, one brother, and five uncles and aunts"; two cases of "father, mother, one sister, one uncle, and one aunt"; two cases of "father, mother, two brothers, and two uncles," and so on. In one case as many as fifteen deaf-mute relatives are recorded. Genealogical trees are given of the families in which deaf-mutism prevails, and the large proportion of the members of those families who are congenitally afflicted is most painfully illustrated. The surnames of the inmates of deaf-mute asylums are analysed, and the frequency is pointed out of the recurrence of many strange-sounding names, such as "Fahy," "Hulett," "Closson," "Brasher," "Copher," "Gortschalg," &c., apparently out of all proportion to the number of persons bearing those names in the general population.

The influences that promote the inter-marriage of deaf-mutes are fully described. The isolation of their class from the rest of the world is becoming more and more complete. Each institution is a self-sufficing *alma mater* where every member feels really at home, and with which each member continues his connection in after years. Gatherings of old pupils of both sexes, *conversaziones*, and other social meetings are of frequent recurrence, and what is most important of all, the highly-developed and very conventional gesture language of the deaf and dumb has already moulded them into a distinct nation. They think not in words, but in abbreviated symbolic gestures, and the sequence and association of their ideas is thus compelled to be idiomatic and widely different from those of the rest of their race. English and other spoken languages are foreign tongues to them, and are acquired, for the most part, very imperfectly. A separate mode of life is so congenial to persons reared under such exceptional surroundings, and of such exceptional natures, that unwise schemes have been from time to proposed, of buying land in settlements for the deaf and dumb, where they should reside and form a secluded society of their own. They are content with their lot when they are brought into contact with none but themselves, but they are ill at ease, and feel themselves to be aliens, when they are forced into the presence of the outside world. What wonder that they should shrink from it, and intermarry and strive to keep apart.

The interest of this strange story is twofold. In the first place it shows how easily a marked and degenerate variety of mankind may be established in permanence by a system of selection extending through two or three generations; and, secondly, it is an instance in which strong social, and possibly legislative, agencies are sure to become aroused against unions that are likely to have hereditary effects harmful to the nation. The advisability of various forms of restrictive measures is judiciously and carefully discussed by the author, with the general result that gesture-language should cease to be taught, the oral system being enforced in its place, and that the philanthropic custom of massing the deaf and dumb together in separate societies, and of making their life as happy as possible in those societies, should be strongly discouraged.

Instructive experiments on the rate at which a deaf breed of animals could be formed, might be made by breeding deaf cats, who are by no means inefficient mousers, and who show no signs of discontent at their lot. I may mention an observation of my own as having some possible pathological bearings. It was this: during a country walk I lunched at a roadside inn, where I saw a female cat with blue eyes, and asked and found that she was quite deaf, but was told that her kittens all heard perfectly. The only one of them that had been kept was in the room, and she certainly noticed my voice and other noises I made to attract her attention, just as readily as other kittens. Then it occurred to me to try her with the shrill notes of one of my little whistles, which I had in my pocket-book. She was absolutely deaf to these, and I doubt if she could have heard a note as shrill even as the chirp of a sparrow. Cats, as I have elsewhere observed, are eminently sensitive to shrill notes, so that the deafness of this kitten was a noteworthy proof that the imperfect stages of the form of hereditary deafness to which she was subject consisted in the degeneration of that part of the auditory apparatus which is concerned in hearing shrill notes. I am told that no thorough anatomical investigation has yet been made into these matters, owing to insufficiency of subjects. It would therefore seem that a breed of deaf cats might be very acceptable to physiologists, and I have no doubt that such a breed might be easily established on any small and sparsely-inhabited island from which every hearing cat had been removed. Cats will not breed in strict confinement, and their roving habits at night make it impossible, under ordinary circumstances, to keep their breed pure; but in small islands, under the paternal despotism of a popular landlord, this and many analogous experiments in breeding varieties of small and hardy animals and plants, such, I mean, as would take care of themselves, might be carried out. I have often envied the facilities afforded to such projects by the geographical and social condition of the Scilly Islands.

FRANCIS GALTON

ASTRONOMICAL TELESCOPES FOR PHOTOGRAPHY[1]

II.

THE simplest form of the reflecting telescope is that in which only one reflecting surface is used, known as the Herschelian, or, as Sir John Herschel, in his work, "The Telescope," calls it, "the Simple Reflector." The remarks he makes on this form are well worth most careful consideration in connection with the use of the reflecting telescope for photography.

All other forms have the second or third mirror only for the purpose of bringing the image formed by the large mirror where it can be more conveniently used. Of these the Newtonian is the simplest and perhaps the best, as here the second reflection does not alter the size of the image, but only diverts it to the side of the tube. In the Cassegrain or Gregorian form the use of the convex or concave mirror enlarges the primary image more or less. Modifications of the Cassegrain form can be made by replacing the small convex mirror by a flat or very slightly curved mirror, in which case, although there is much loss of light, the image is kept nearly the same size as in the Newtonian. There is also the "Brachy" form, where the Cassegrain is used obliquely, but this is practically a Cassegrain. In all these telescopes, except the first and last-mentioned, the second mirror requires support of a kind that acts most injuriously on the image, causing rays to come from stars which, in the case of stars as faint as eight magnitude, show quite distinctly with such long exposures as are needed in photographing the nebulæ or clusters of very faint stars. In addition to these well-known forms of the reflecting telescope there is the arrangement of three reflectors as a telescope indicated by me in the May number of the *Monthly Notices* of the Royal Astronomical Society, and also the application of the Coudé principle, treated of at length by M. Lœwy in the June number of the *Bulletin Astronomique* (1884). As far as I know there has not been any practical application of the Coudé principle to the reflector. The need of three reflections would involve great loss of light, and for this reason alone would render it unsuitable for photo-

[1] Continued from p. 40.

graphy where so much depends on the power of the telescope to bring together as much light as possible on the surface of the sensitive plate. Apart from this great loss of light there would be enormous difficulties in making such a telescope of even three-foot aperture, indeed, I am very doubtful if it could be done, there is the difficulty of keeping the different mirrors free from flexure and in proper adjustment, there is the fact that the form of mounting that must be used to carry the ponderous mirrors would be that most unfavourable to the good performance of the whole as a telescope in regard to the atmospheric disturbance due to the mounting; and last, though not least, the position of the external plane mirror would be so exposed that it would not stand many nights' work; with the flat mirrors of a Newtonian telescope one has much difficulty, as a slight rise in temperature will dew them at once, and under ordinary circumstances they become very soon so dull that they require re-silvering many times more frequently than the large mirror. Certainly the large plane mirror would conserve its heat better than the small flat of a Newtonian, but from the exposed position it would occupy, it would certainly be a source of continual trouble. There is only one good thing in such arrangements, and that is that the observer has not to follow the eye-piece, which only rotates, and does not change its position. For general observational work this becomes of importance. For comet-seeking, for which I believe this telescope was first used, it is difficult to imagine a more suitable arrangement than that brought again to the notice of astronomers by M. Hermite in *L'Astronomie*, October 1884, though his proposition, to dispense with a tube or to use a fixed one, would make a difficulty at the eye-end, where the image would rotate, as it would in the case of a fixed telescope with a mirror moving in front, after the manner of a siderostat. For photography all those latter forms of telescope are not admissible; even for large fields, when a refractor specially made was used, it would be better to use it as a simple equatorial than to lose the light by two additional reflections. Considering carefully the different reflecting telescopes enumerated above, there does not appear to be anything that can be more simple than the Herschelian, and nothing more suitable, judging from what has been done, than the Newtonian; nor does there seem anything in any other form that offers greater advantages than these, either on the grounds of simplicity, easy manipulation, possible increase of size, and, what is of vital importance, smallness of first cost; it is on one or the other that I should entirely rely as the photographic telescope of the future; whether the Herschelian form would be better in practical use than the Newtonian, or, rather, whether the reflecting surface could be made as good in this case, would only be shown by actual trial; if it could then, for the reason already mentioned, the image would be the best, and the best kind of telescope for the purpose of photography would be found.

In the Newtonian, as has been said, the plane mirror is only used to bring the rays, that would form the image otherwise in the centre of the tube, out at the side, but as the object is not to be viewed, but photographed, the plate can be placed in the proper place to receive those images direct from the large mirror, as was done by Dr. De la Rue when he first used the reflecting telescope for photographs of the moon.

There are some difficulties in getting a proper supervision of the exposure, but these are not insuperable. A mounting for the Newtonian reflector pure and simple would be equally suitable for the Herschelian, so that if it were decided to make a large telescope, no danger would be run that success would not be certain; if the Herschelian gave such excellent results, as I think might be fairly expected, so much the better, if it did not, the telescope that has already shown its capacity would simply remain what it is now—the only telescope suitable for photography on such a scale as can be really useful.

As to the way in which such a telescope as I here contemplate, that is, a reflector of from 5 to 8 feet aperture, should be mounted, there would be a certain safety in following the plan I have found so good with 3 foot, with such mechanical alterations as the use of water in place of mercury for the floating medium would render necessary. The general principles, I believe, are correct as regards the conditions that affect the performance of the telescope as an optical instrument.

The duty of the observer would now be entirely limited to seeing that the image fell always on the same place on the plate during exposure, a duty that is easily described, but not so easily done. For this purpose he must have such optical arrangements that he can from the ground watch the position of the image of a star anywhere near the object to be photographed in its relation to a cross wire attached to and moving with the sensitive plate, so that if, from the many causes that can produce a shift of this star and of the image on the plate, there is a slight movement, he can at once correct it. The telescope would work entirely in the open air under the most favourable conditions and without any disturbance from the body of the observer, as he would not be near the high end of tube. The large mirror would be protected from dew by a slight covering round the skeleton tube, and have an apparatus to cover it up quickly, and so be in the best condition to keep its polish, and with the absence of a small mirror and its trouble at the high end of the tube, simplicity would be followed to its fullest extent without the sacrifice of one essential point.

Such a telescope would be capable of giving photographs of all the nebulæ, with exposures of from 30 to 60 minutes, of the various clusters, and of certain selected parts of the heavens, and this should be for some years its chief work. About the value of such a work it is quite unnecessary to speak—to show that it can be done is quite enough.

In thus giving my opinion as to the best kind of telescope to use for this most important part of astronomical photography I place it first for its importance. That much could be done by a smaller instrument, or, rather, by many smaller instruments, of a most valuable character, I have not any doubt. It is quite possible now, by means of photographic lenses, to take stellar photographs that are of great value; and any equatorial reflector, and many refractors, if they have driving apparatus of fair quality, could be most usefully employed in photography, and that without any more knowledge of the art of photography than could be learnt in a few minutes; by taking photographs of a small portion of the sky that could be identified, and working entirely at that, the amateur astronomer, with any aperture over 6 or 8 inches, could make a monograph that would be good for all time, and his results would not be the mere expressions of impressions on his mind through his eye, but would be visible ones that would speak for themselves as to their value. In all departments of stellar photography, excepting of course absolute positions, I think that photography is at once available. It is remarkable that the silver-on-glass reflector has proved itself to be capable of practically unlimited increase in size and to be so well fitted for photography at the same time that the photographic process has been brought to such a state of perfection, especially in this country, the home, if not the birthplace, of the reflector. At the present moment a gigantic stride in advance is to be made with certainty of success, and that at a cost that is insignificant compared to the results that must come. Let us hope some one who can hasten this step will come forward; if one cannot, many must, for it should not be delayed.

A. Ainslie Common

SOME EXPERIMENTS ON FLAME

IN December 1881 my attention was casually called to the popular superstition that sunlight puts the fire out. Returning from a walk I had found the blinds of my sitting-room closely drawn, for the benefit, as I was told, of the fire, which was low. On my appearing somewhat sceptical about the use of this proceeding, my landlady cited the above-mentioned superstition as a well-known fact. For her benefit and instruction I made the poker red hot, and focused the sun's rays on it with a bull's-eye, showing her that, though the bright light prevented the red heat from being seen, it had not extinguished it, and was, moreover, capable of making a smaller piece of metal red hot. But I was myself so struck with the power of even the December sun in overcoming the light of the most highly incandescent body, that I determined to make further experiments. Even the intense glow produced by heating in the blowpipe-flame a small piece of chalk, though it was sufficient to light up the whole room, entirely disappeared in the sun's rays. This led me to ask what would be the result of testing the sun's light in the same way against that of a flame. If, according to the older theory, luminous flame consists of incandescent solid particles, then I should expect that these would behave under the strong light exactly as the white-hot iron did, while, on the other hand, if as some have maintained the white light of a flame proceeds from gases of great vapour-density, then I might expect results which, if not different, would be at least interesting.

Experiment 1.—Accordingly, on December 7, 1881, I arranged my large condenser—a lens 5 inches in diameter, and 20 inches focus—so as to throw the image of the sun upon the flame of a paraffin candle. To my delight a round spot of light of a bluish-white colour and peculiar soft appearance was visible on the flame itself. That the flame, whether gaseous or consisting of incandescent particles, could reflect light, was certain. It remained for me to determine the characteristics of this reflection. From its colour and peculiarly "soft" appearance it reminded me of fluorescence. I therefore proceeded to test the question with the spectroscope.

Experiment 2.—I examined first the spectra given when a beaker of petroleum or one of solution of quinine sulphate was placed in the focus. I should mention that my spectroscope, which I designed and made myself, slides up and down the supporting pillar, so that it can be adjusted to any height. The table carrying the slit, and telescope, and prism (dense flint of 60°), can be fixed in three positions to the stand, so that the slit may be vertical, horizontal, or directed vertically downwards for examining solutions with the light thrown up from beneath. It is also provided with a doublet, equivalent to the B eye-piece of a microscope, used as a condenser to throw the image, which may be an enlarged or diminished one at pleasure, of any object upon the slit. The whole arrangement is very simple, and far more convenient than that of the ordinary laboratory spectroscope. Bringing the instrument thus armed to bear upon the strongly illuminated solution, I found the field of view to be filled with a soft and even light, that seemed to obscure the Frauenhofer lines as if some thickened luminous solution had been poured over them. Every moment some particle of dust floating into the focus would cause a tiny flash as its image crossed the slit, of hard clear light, like that of the candle-flame, only that it showed the Frauenhofer lines. But after filtering the solution, carefully cleaning the beaker, and excluding all extraneous light, the Frauenhofer lines vanished, and nothing was visible either with quinine or petroleum but the soft continuous spectrum of fluorescence. I have described these well-known phenomena thus minutely that I may emphasise the very different results obtained in the following experiment. To the naked eye the spot of sunlight upon the candle-flame was of exactly the same soft quality, and nearly the same colour as that upon the fluorescent solution. I replaced the candle in the focus, arranged the condenser of the spectroscope so that the white spot should come upon the centre of the slit, and occupy one-third of it. The field of view was filled by the spectrum of the flame, but across the centre was a bright band of light extending far into the violet, brightest in the blue, and showing *all the Frauenhofer lines distinctly*, especially in the blue and violet. Unmistakably I was dealing with reflected light, and not with fluorescence. My thoughts at once reverted to Prof. Tyndall's "blue cloud." I knew of two ways of producing an extremely fine precipitate showing the same characteristic phenomena. I added dilute hydrochloric acid to a weak solution of sodium hyposulphite, but this preparation I found to be troublesome from the rapidity with which it loses its optical properties, so I discarded it in favour of the following. I diluted some French polish with about fifty times its bulk of methylated spirit, and added a few drops of the solution

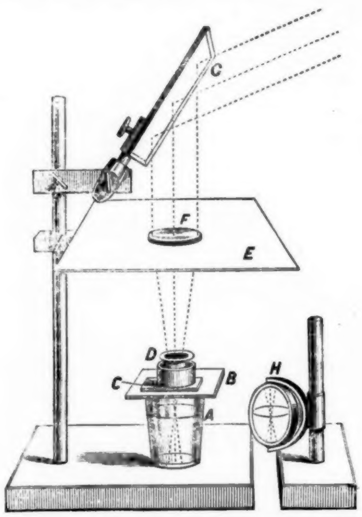


FIG. 1.—A, tumbler containing "lac precipitate"; B, glass plate to support polarising apparatus; C, selenite film; D, polarising prism; E, sheet of cardboard to screen off superfluous light; F, lens to concentrate the light; G, mirror; H, side mirror in which the colour of the beam in a different azimuth may be seen.

to a glass of water. The precipitate of lac resulting is sufficiently fine for every purpose, and will remain in suspension for days. The light from the heliostat passing through this solution gives the same soft opalescent reflection, with the same spectrum strongest in the blue and violet, showing all the Frauenhofer lines distinctly, as it does upon the candle-flame.

Experiment 3.—There is another special characteristic of matter in extremely fine division common to Prof. Tyndall's "blue cloud" and the above-mentioned solutions. Light reflected from it is completely polarised in the plane at right angles to the line of incidence. I am in the habit of showing this by the following arrangement, which I believe to be new, and which is so simple that any one can exhibit it. It is shown in Fig. 1. A is an ordinary plain tumbler, half filled with "lac precipitate," and covered with a piece of window-glass, B. On B is laid a mounted selenite film, C, and upon this again the polarising prism D, used with the microscope. A retort-stand supports a sheet of cardboard, E, with a hole in the centre, which shades the liquid from superfluous light,

and also carries a lens, F, which may be an ordinary eye-glass laid across the hole, and so adjusted that its focus shall come about the middle of the liquid. A plane mirror, G—a hand-glass will do—is then either held or fixed, so as to reflect sunlight perpendicularly upon the lens. It will readily be seen that the light, concentrated by the lens, is plane-polarised by the Nicol prism, then modified by the selenite, and finally analysed by reflection from the extremely minute particles of lac. Accordingly, to a person walking round the table with his eye on a level with the tumbler, the vertical beam of light in the liquid appears to change colour four times. Thus, if the selenite and Nicol are so adjusted that viewed from the west it appears blue, then from the south it will be yellow, from the east blue, and from the north yellow again. If then the selenite be removed from under the Nicol, from both west and east it will be seen as a bluish-white beam of light, while from the north and south it will be invisible altogether, as though a screen had been placed over the lens. By arranging or holding a small mirror, H, at an angle of 45°, by the side of the tumbler, the observer may see the blue colour of the beam from the west side, on which he stands, while at the same time the mirror shows him that its colour, when viewed from the north or south, is yellow. Or three mirrors may be arranged so that all four aspects of the beam may be observed at once. I do not know a more beautiful and striking way of demonstrating the properties of the polarised ray.

Experiment 4.—I now come to the most interesting of my experiments. This polarisation of all light reflected at right angles to the line of incidence is, I believe, accepted as the special characteristic of very finely-divided solid matter. I applied the test to the light upon the candle-flame. I held the Nicol in the plane at right angles to the mean path of the rays, looked through it at the soft spot of reflected sunlight, and rotated it. When the crystal crossed the line of incidence at right angles, the spot vanished; when it coincided with it, the spot was brightest. With a selenite film in addition to the Nicol prism the usual change of colour could be seen, the red and green film showing more distinctly than the blue and yellow. By using the Nicol over the eye-piece of the spectroscope I found that every part of the spectrum of the reflected sunlight is polarised alike, showing that the flame behaves with respect to light exactly as a solution containing extremely fine solid particles. I made a large number of experiments with a view to ascertain how far this similarity would hold, and I now proceed to give some of the most important.

Experiment 5.—I arranged the heliostat with the candle-flame in the focus and the spectroscope at right angles to the line of incidence, with the Nicol prism over the eye-piece, and the condenser arranged to focus the "white spot" of sunlight on the slit. I then gradually lowered the candle so as to bring the apex of the flame into the light. There was no break in the appearance of the spectrum on passing from the hot flame to the non-luminous smoke. Low down, the flame reflected only the more refrangible rays, as far as the middle of the green; towards the apex it reflected also the red. All the reflected light was polarised.

Experiment 6.—With the same arrangement as before, I turned the spectroscope so as to have the slit horizontal. I burnt some soda in the Bunsen burner at a little distance, so that the vapour from it came to the candle. The result is depicted in Fig. 2. The continuous spectrum of the inner flame is crossed by the bright sodium lines which project a little distance beyond it on either side to the limits of the outer flame. In the centre is a bright band, the spectrum of the sunlight on the flame, and on this all the Frauenhofer lines, *including the D lines perfectly black*, as in my drawing. It was very curious to see the two ends of the sodium lines standing out bright against the dark background on either side, visible still as bright lines, though faintly, upon the flame itself, up to the band of sunlight, and then strongly reversed by contrast with its greater brilliancy. I believe I am the first who has succeeded in reversing the sodium lines by reflection. It requires a bright sun to do this; otherwise the red end of the spectrum is not strong enough, but I have succeeded in showing it to several friends.

Experiment 7.—With the same arrangement, substituting a spirit-lamp charged with soda for the candle, nothing was visible to the naked eye; the flame seemed

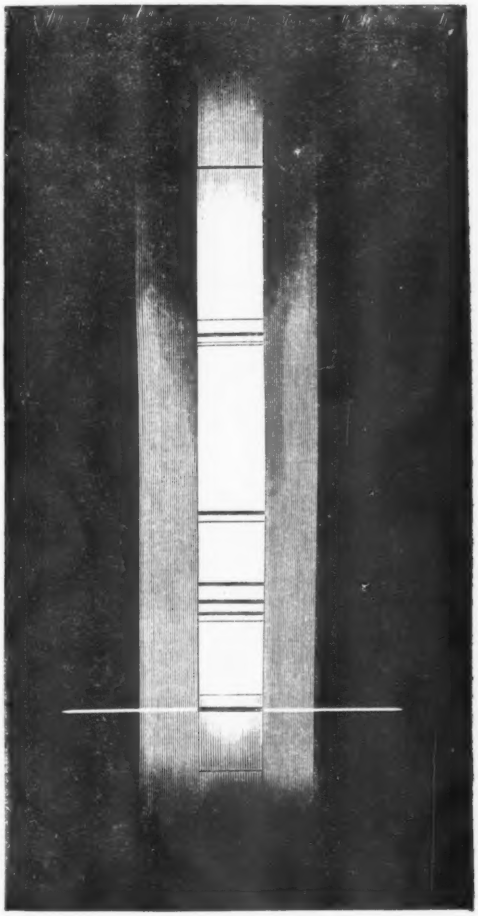


FIG. 2.—Spectrum of candle-flame in the focus of the heliostat, showing the D lines reversed by reflection.

to vanish in the glare; only in the spectroscope the bright lines were seen unaltered. With the Bunsen a brightly illuminated column of dust was seen rushing out of the tube, each particle vanishing as it reached the perfectly invisible flame, and was burnt. Several substances, *e.g.* copper oxide, and ammonium molybdate, give in the outer flame a spectrum which in my small instrument appears continuous, though lacking the "hard" look of the spectrum of an incandescent solid. But they give *no reflection* with the strongest sunlight, behaving as true vapours. It will be observed that, though I have

shown that a substance capable of emitting light of *all* wave-lengths may be capable of reflecting at the same time light of *any* wave-length, yet I have not been able to show whether or not a substance emitting light of one definite wave-length may not be able to reflect light of that same wave-length, though I have proved that it can reflect no other. For instance, the light given by sodium is absent from that of the sun, so that my experiment proves nothing with regard to it; yet that particular light is not transmitted through hot sodium vapour, but is stopped by it. One would think it must either be reflected or its energy must be used up in some way on the vapour itself. I have been unable to get access to the electric light, and no other light I know is strong enough for this experiment. I have wished also to try whether sodium burnt under pressure, or at a very high temperature, would or would not have the power of reflecting light; but in this direction I am again stopped by lack of apparatus.

Experiment 8.—The spectrum of the light transmitted through the lac solution is complementary to that reflected by it, *i.e.* the reflected light is bluish, and the transmitted yellowish-brown; in the latter case the spectrum is weakened towards the violet, and in the former towards the red. I desired to see if this was so with flame. I arranged a metallic screen with a slit one-fourth of an inch long and one-twentieth wide, close to the candle, so that all light falling upon the spectroscope must first have passed through the luminous portion of the flame, and then with a mirror directed the sunlight into the instrument. Pure sunlight was thrown into the upper half of the field for comparison, by means of the reflecting prism. Having adjusted the light so that no difference could be detected between the upper and lower halves of the field of view, the candle was placed in position in front of the slit. There was a very definite general absorption, most noticeable in those rays that are deficient in lamplight, especially about F and G, where also the spectrum of the reflected sunlight is brightest. The experiment is difficult owing to the necessity of reducing the brilliancy of the sunlight without so far reducing the angle of the illuminating ray that the hot air-currents may vitiate the result. But after many trials I satisfied myself that the more refrangible rays of light transmitted through a luminous flame are to some extent absorbed, the effect being stronger in proportion as the smoky part of the flame is approached.

Experiment 9.—It seemed evident that the reflection of the sunlight from the flame was due to its superior intensity; I therefore judged that, if I could lower the temperature of the carbon somewhat, I might get a visible reflection with light from other sources. I held an iron nail in the flame, and focused on the resulting smoke the light from a petroleum lamp. The spot of light was plainly visible, only not of a bluish white as with sunlight, but of a dirty yellow colour. It could be seen not only on the cold smoke, but also where it was of a bright cherry red; beyond that it became lost against the brightness of the incandescence. But the smoke, whether hot or cold, polarised the light exactly as the fine precipitates did.

Experiment 10.—In order to get rid of the disturbing effects of the light from the candle itself, I punched a hole in the middle of a tin plate, and placed it over the candle. The column of smoke coming up through the hole completely polarised the light thrown on it, whether from a lamp or from the sun, at right angles to the line of incidence. I then placed a little tuft of asbestos saturated with melted paraffin upon the hot plate. It gave off a dense smoke, indistinguishable to the eye from that of the burning candle. On applying the spectroscope, however, the difference was manifest. The light reflected by it was *not polarised*. I would therefore suggest that this polarisation test be the distinction between "steam," however dense, and a true "smoke." I have reason to believe that a polarising smoke only arises where the heat causes decomposition.

Experiment 11.—I placed the under side of the tin plate in the light, and found that the soot upon it reflected plane-polarised light in all directions at right angles to the line of incidence.

I now desired to ascertain if this power of reflecting light is confined to substances burning in the inner flame. It is difficult to make accurate observations as to the spectrum of the inner flame with an ordinary Bunsen burner, from the fact that it is completely surrounded by the outer flame; and this last, being but feebly luminous, gives only a very faint spectrum. I wished to make an arrangement by which the spectra of the two flames could be completely separated, while at the same time their intensity should be increased. Accordingly, I made a Bunsen burner with a rectilinear aperture, two inches long by an eighth of an inch wide, in place of the usual round tube. This gave me a broad flat flame, the edges of which I allowed to play each against a piece of well-annealed glass, so that I could look through the glass and see the flame edgeways. In this way I got a very strong spectrum of both the inner and the outer flames, perfectly distinct from each other, the ends of the flame being cut off by playing against the glass. The inner flame with its bright lines was thus completely separated from the outer with its soft, apparently continuous, spectrum: under sufficient pressure, the separation extended to the eighth of an inch or more. I could see no lines across this intervening space, except perhaps that in the violet: as to which I am not quite sure. Of the others I am certain, and I think the space is perfectly dark. As the glasses soon crack, I substituted another arrangement, which I hope still farther to perfect. In this flame I burnt a number of substances, keeping the image of the sun upon it all the while, and having the spectroscope with polarising prism, &c., arranged as in Experiment 5. I here give the results of two of the most interesting of these experiments.

Experiment 12.—I burnt on a piece of wire a mixture of copper sulphate and ammonium chloride. This compound, as is well known, gives a very beautiful and complex spectrum. When the mixture is held in the inner flame it turns dark, bubbles up, and burns like a piece of pitch, giving a continuous spectrum; and upon this flame, which never passes beyond the inner flame, the reflection of the sunlight may be seen and the Fraunhofer lines distinguished. There is also, at the same time, in addition to the beautiful blue-violet coloration of the outer flame, a curious "red smoke" right on the outer edge of it. But though in a dark room this looks far more like a solid precipitate, or true smoke, than the bright flame—though by daylight it looks so "smoky" that I thought it surely must give what I sought, a reflection in the outer flame—yet the sunlight passes through it without the slightest effect, save that it renders it invisible. The spectrum of this apparent smoke consists of groups of lines in the red.[1]

Experiment 13.—I now sought a substance that should be volatile in the inner flame and give a non-volatile oxide in the outer. I placed some zinc, which I found to be the most manageable metal for this purpose, in a small iron cup in the very centre of the flame. As soon as it boiled, flashes of white light appeared in the outer flame, and I was enabled to ascertain that these flashes gave a continuous spectrum and were also capable of reflecting sunlight, the reflected light being polarised, as in the other cases, in all directions at right angles to the line of incidence.

[1] In a recent experiment this "red smoke" gave a "soft" continuous spectrum from the extreme red to the yellow a little beyond D. It is very transient, and seems to be produced when the fused mass is drawn nearly out of the flame.

I venture to think, therefore, that the proof is fairly complete that the luminosity of a candle or gas flame proceeds from incandescent matter in a state of extremely fine division, because—

(*A*) Light can be reflected from it in the same way as from very fine particles of lac, sulphur, &c.

(*B*) The reflection begins with the violet rays when the precipitate first forms, and extends to the red as it becomes denser in the upper smoky part of the flame, the spectrum undergoing a similar change to that of the acidulated hyposulphite solution.

(*C*) There is no break in the phenomena from the commencement of incandescence to the cooling smoke and even the cold soot itself. The reflection is visibly produced by any rays, whether of the sun or from a lamp, that are more intense than those of the incandescent body; and I imagine that light that is less intense is still reflected, though it cannot be discerned.

(*D*) The spectrum of light transmitted through a flame is complementary to that reflected from it, as is also the case with a solution containing fine particles.

(*E*) The peculiar property of polarising all light reflected at right angles to the line of incidence which is considered the test of solid matter in extremely fine division is possessed by all flames giving what is known as the "solid" spectrum.

(*F*) Whenever a precipitate is actually formed by a reaction known to take place in either inner or outer flame, the resulting luminous flame has the optical properties described in this paper. Thus zinc, which produces these results only in the outer flame, gives evidence of the solidity of its oxide in the form of smoke. And with the mixture of copper sulphate and ammonium chloride it is not that part of the flame that looks most like smoke to the eye, but that which gives a "hard" continuous spectrum which is found capable of reflecting light.

I am still working on the lines indicated by these experiments, and though the foregoing is all I feel justified in publishing at present, it by no means contains all the suggestive results I have obtained in my endeavour to ascertain the cause of luminosity in gases and substances vaporised in the Bunsen flame. My time is very much occupied and my appliances limited: it may be long before I can complete my researches, so I have thought it well to make public my conclusions, so far as they go.

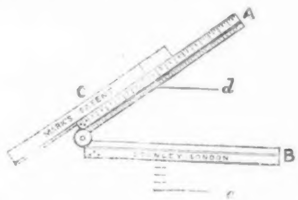
GEORGE J. BURCH

A LINE-DIVIDER

GALILEO'S proportional compasses are said to date from the year 1597. We infer that the instrument consisted of two arms, jointed, as in the accompanying figure, so that one arm could move freely about the joint. Each arm had a number of equal divisions (not necessarily of the same length on each arm), the zero point being at the joint. To divide a given length into five equal parts it is necessary to take an ordinary pair of compasses and measure the given length with these, then set the proportional compasses so that the fifth division on each arm may be at the given distance apart, then transfer with the ordinary compasses the distance between the unit divisions—this will be one-fifth of the given line. This seems to have been the manner of using the instrument employed by Galileo (cf. Marie, *Histoire des Sciences Mathématiques et Physiques*, tome iii. p. 108). Other modes of using will doubtless occur to most of our readers. The principle involved in this and similar instruments, and certainly in the one before us, is that of the proportionality of corresponding sides in similar triangles.

Our figure represents Miss Marks's patent line-divider for dividing any space into a number of equal parts. A B forms a hinged rule with a firm joint; each limb is ten inches in length (in the specimen we are describing), the limb B is bevelled, fronted with brass, and presents a straight edge, so that straight lines can be drawn along it. The limb A is also bevelled, and is divided on the bevelled edge and also on the top into eighty equal parts, so that we are enabled to divide a given length into any number of equal parts from two to eighty. A is fitted to slide in an undercut groove upon the plain rule C, which has a single line marked upon it, and is also provided with needle points on the under-side, to prevent it from slipping when placed in any position.

Suppose we take the case already considered. Slide C along A till the C line coincides with one of the lines on A, against which is the number 50. Place the corresponding line on the level of A on one end of the line to be



divided, then open out or close up the rule till the bevel of B passes through the other end of the line. Now press the points on the underside of C firmly into the paper, and slide A up till the number 4 on the line of reference is coincident with the line on C, and mark the point where the bevel of B meets the given line to be divided. Continue to move A up one division at a time till the whole line is divided. If we require lines to be drawn through the several points of division in a given constant direction, it is obvious that we must fix the instrument so that the bevel of B shall be initially in the given direction.

We have said enough to show how the divider is used, and it remains only to state that it appears to be a very handy instrument for architects, engineers, and practical drawing. Stanley, of Great Turnstile, Holborn, is the maker.

UNIVERSAL TIME AND THE RAILWAYS

ONE of the reasons why the Prime Meridian Conference met at Washington was that the United States possesses the greatest longitudinal extension of any country traversed by railway and telegraph lines, and it is quite in keeping with the spirit of American institutions that some of the most important measures necessary to carry out the resolutions of the Conference were taken by the railway men before the scientific men had begun their sittings. The action of the railway companies began as far back as 1883. It was a regular rebellion against the inconvenience of having more than half a hundred standards of railway time from east to west of the continent. At the Conference itself, Mr. W. F. Allen, one of the United States delegates, who has from the first taken the greatest interest in this special branch of the subject, brought the matter prominently before the Congress, stating what had been done. Since the Conference met, the suggestions primarily due to the railway authorities have been accepted by the Army Signal Corps and other public bodies, and from the east of Canada to the Pacific the Continent is now divided into five sections, each with its time standard, differing by one hour from those to the east and west. Thus we have Intercolonial time, Eastern time, Central time, Mountain time, and Pacific time, representing differences of one hour or 15° of longitude. We append a map, and a paper by Mr. Allen, which we have received

from an esteemed correspondent, which will show at once the history of this movement and what has come of it.

I. On November 18, 1883, the principal railway lines of the United States and Canada adopted a new method of computing and recording time, for the purpose of securing *a uniform time standard* which should simplify the business of transportation and add to the convenience of travellers. It is almost wholly for purposes of travel and transportation that the majority of people have need of accurate time, and everywhere, except in very large cities, business has always been regulated by railroad time.

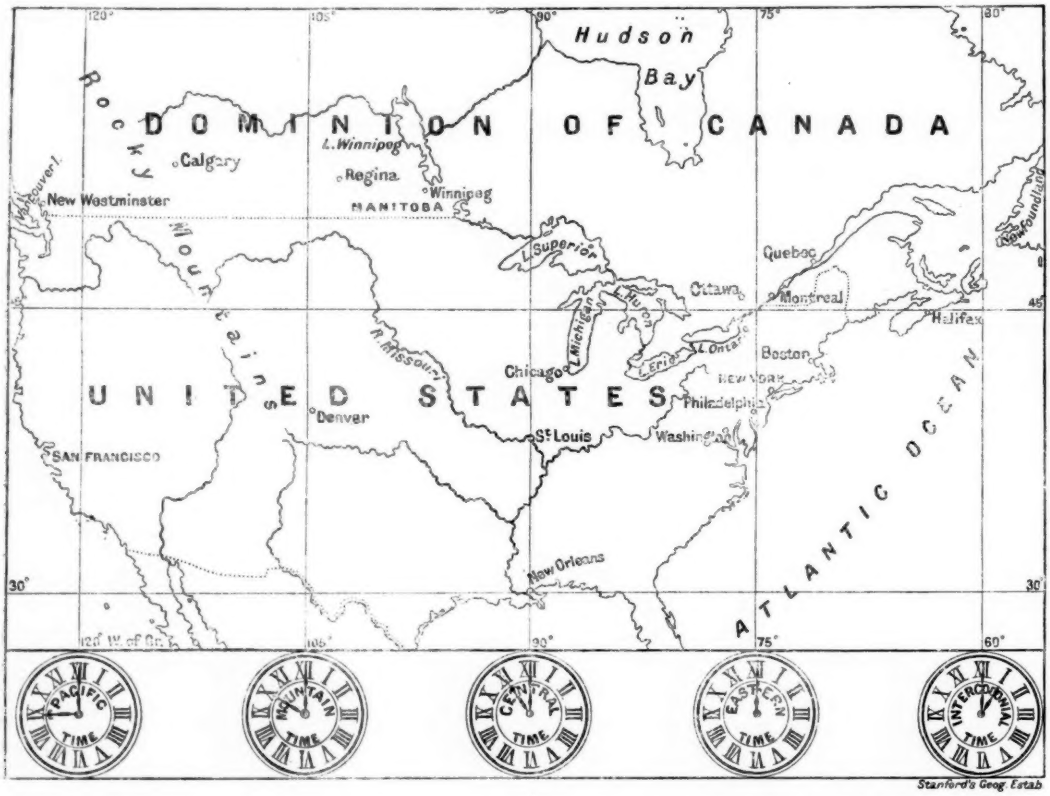
II. The defects of *the old system* of time standards were mainly as follows :—

(1) There were formerly more than fifty standards of railway time in the United States. Now there are but four.

(2) The old standards differed from each other, where they intersected, by all sorts of variations, errors, and odd minutes. Now the differences between the standards are an exact hour, and the minutes and seconds are the same in all four divisions.

(3) Formerly there were almost innumerable places at which standards changed. Now the points of change are few in number, and always at prominent points of railway departure.

(4) Formerly almost every railway centre had two or three standards of time. Chicago used three; Kansas City had five; and St. Louis, where fourteen roads centre, used six different standards.



Stanford's Geog. Estab

III. In the plan which has now been adopted it was proposed :—

(1) That the same standard should govern as many railroads as possible.

(2) That the standards should not extend over so large an area of territory as to cause standard time to differ at any point by more than about thirty minutes from local time (mean solar time).

(3) That each standard should vary from the adjacent standards by the most readily-calculated difference, that of an even hour.

(4) That changes from one standard to another should be made at well-known points of departure.

(5) That these changes should be made at the termini of roads where changes naturally occur, except on the transcontinental lines, and in a few other unavoidable cases, where they should be made at the ends of divisions.

(6) That the 75th meridian west from Greenwich being almost precisely the central meridian for the system of roads using standards based upon the time of eastern cities, and the 90th meridian being equally central for the roads running by the time of western cities, the time of those meridians should be adopted for the territory which includes nearly 90 per cent. of our whole railway system. The hour meridians east and west of those named (the 60th on the east, and the 105th and 120th on the west) were found to be equally well adapted as central meridians for the roads in the section of country adjacent thereto.

IV. The problem in this country presented a feature nowhere else encountered. Standard time was introduced

throughout the island of Great Britain as long ago as the year 1848. When the railways demanded uniform time, and Greenwich time was adopted. France also has a uniform standard. But the continent of North America covers too many degrees of longitude to permit of the use of any one meridian as a single hour standard for all points between the two oceans. Under such a system there would be points where local time would differ from standard time by about two hours.

V. *The new system* divides the United States into four sections. At all places in the same section time is the same. The first section, which is governed by the time of the 75th meridian west from Greenwich, embraces all the territory between the Atlantic coast and Detroit, Pittsburg, Wheeling, Parkersburg, Huntington, Bristol, Augusta, and Charlestown, as indicated on the accompanying map (see next page). This is called *Eastern Time.* At 12.0 mid-day on the 75th meridian every clock and time-ball, from Calais to Pittsburg and from Quebec to Charlestown, indicates the hour of noon.

The second section is governed by the time of the 90th meridian, called *Central Time.* It includes all the territory from the western limits of the eastern time (that is, from Detroit, Pittsburg, Augusta, &c.) to Bismark, North Platt, Dodge City, &c. Time in this section is one hour slower than eastern time.

The third section extends from the last-named places westward to Heron (Montana), Ogden (Utah), the Needles (Arizona), &c. Time in this section is that of the 105th meridian (one hour slower than central time), and is denominated *Mountain Time.*

VI. At 12.0 noon in New York City the time at Chicago is 11 a.m., at Denver 10.0 a.m., and at Portland (Oregon) 9.0 a.m. By the old system at 12.0 noon in New York it was 11.05 in Chicago, 9.56 in Denver, and 8.46 in Portland.

VII. The adoption of a uniform standard of time by the railway lines has led to the *abandonment of local time* in nearly all the cities of the United States. The time of the 75th meridian was selected as the standard for the district of Columbia by Act of Congress, approved March 13, 1884.

It is encouraging to learn that, as was to have been expected, local time throughout the United States, as opposed to railway time, has already been abolished, and it is to be hoped, for the benefit of railway travellers on this side of the Atlantic, that the continent of Europe, from the extreme west of Spain to the Caspian, will soon be dealt with in the same manner.

NOTES

WE regret to state that Prof. Benjamin Silliman, of Yale College, died at Newhaven on the 13th inst., aged sixty-eight.

THE death is announced of Prof. Friedrich von Stein, at Prague, at the age of 67. He was appointed Professor of Zoology and Zootomy of the Prague University, an office which he occupied for thirty years.

THE death is also announced, at the age of fifty years, of Col. Roudaire, whose name is intimately associated with the project of a Saharan Inland Sea. Although strongly supported by M. de Lesseps, the scheme was opposed by the great number of competent scientific authorities. With the death of Col. Roudaire the scheme will probably fall to the ground.

THE Vice-Chancellor of Cambridge has appointed Mr. George John Romanes, M.A., F.R.S., to the office of Sir Robert Rede's lecturer for the ensuing year.

THE Royal Academy of Turin announces the foundation of a prize of the value of 12,000 francs for the most useful and striking discovery in anatomy, physiology, pathology, the exact sciences, history, geography, or statistics. The period within which the work must be done or the discovery made is from 1883 to December 31, 1886. Members of the Royal Academy or the Academy of Science in Turin are ineligible for the prize, the judges for which will be the Academy of Sciences of Turin.

THE Academy of Sciences, Berlin, announces the following subject for a prize of 2000 Marks, which, if sufficient merit be shown, will be awarded on the Leibnitz Anniversary in 1887:—"A determination of the nature of the primary assimilation-products of carbon-dioxide in plants; to be based upon suitable experiments and chemical investigations into the process in plants, when exposed to the influences of light; as well as upon direct histological demonstrations of the form it assumes in the tissues of the plant. The first form assumed by the assimilation-product is to be distinguished from the succeeding ones which the substance passes through in the metabolism of the cell. The chemical formulæ are also to be given. It will be considered an approximation to the solution of the question, if, by going over the work that has been done already on this subject, it shall be shown by an accurate series of observations and experiments that the present theories concerning the process of assimilation in plants and the primary organic product of this process, are susceptible of a wider extension, or that they require to be limited by important qualifications." Essays may be written in German, Latin, French, English, or Italian, and must be forwarded before January 1, 1887.

FROM subsequent information with regard to the accident to Dr. Divers, Principal of the Imperial College of Engineering, Tokio, it appears that he had taken in his hand a bottle supposed to contain perchloride of phosphorus, but, finding the stopper fast, was heating the neck to release it, when it burst, the bottle disappearing as dust, and the contents as gas. Dr. Divers was nearly suffocated by the fumes, and one eye was injured. When the last mail left, it was not in a state to be critically examined; but strong hopes are entertained that the sight will be restored. The accident is supposed to be due to the decomposition of the perchloride of phosphorus, which was old. Dr. Divers was at work on a paper on the theory of acids when the accident occurred.

THE undertaking to transport a whole Japanese village, with its shops, houses, and inhabitants, half round the globe to London, was a somewhat bold one for a private individual. But it has been performed with great thoroughness and success in the case of the Japanese village now on view at Knightsbridge. The houses are new and clean, which the tenements of Japanese villages always are not; the small temple or shrine is rather more cleanly and ornamental than is usual with these structures in real life; the wrestlers do not exhibit the physical characteristics which are so conspicuous, not to say disgusting, in the real Japanese wrestler; and their methods of refreshing themselves between the bouts are more in accordance with European tastes. But, on the whole, home-loving English people have now an opportunity of seeing the Japanese at home, which they can never have without a journey to Japan itself. There is very little to note in the exhibition from a scientific point of view; the inhabitants are fair average specimens of Japanese artisans and shopkeepers, so that the ethnologist will have a good opportunity of comparing his notions gathered from Miss Bird and other writers of the Japanese people with the reality. He can, in a measure, study the racial characteristics of the Japanese *in situ.*

THE Spanish earthquakes have continued to manifest themselves at intervals during the past week in the same area as that in which they first appeared. In connection with this phenomenon, the following extract from the report of the meeting of

the Spanish Natural History Society of January 7, 1885, has been forwarded to us from Madrid for publication:—Mr. Joseph Macpherson made the following remarks on the earthquakes in Andalusia:—"The earthquake which took place in the peninsula on the night of December 25 last, and which cannot yet be said to have ceased, has assumed a character of such intensity, and presents in its action such marked coincidences with the geological structure of this part of the world, that I think it will be interesting to enter into some detail with regard to the principal conclusions to be deduced from that phenomenon. Taking the whole peninsula, the disturbance may be divided off into three successive phases, viz.: one of relatively slight importance which occurred in the early morning of December 22, and which was confined to the western portion of the country, its effects being felt only in Galicia and Portugal; another, of the highest importance, which occurred three days later, namely, at 9 p.m. on the 25th of that month; while the third phase includes the oscillations which have taken place, and are still taking place, in the districts most severely affected by the earthquake of the 25th. That earthquake extended over a very considerable surface, the district affected to an appreciable degree including approximately, it would seem, the whole country lying between Cadis and Cape de Gata and between Malaga and the Carpathian range. According to all the data known to us so far, the oscillations gained in intensity as they proceeded southwards from those mountain ranges, reaching their maximum of motion in the region lying between the mountains of Ronda and the Sierra Nevada. The shock was quite perceptible at Madrid, where it was strong enough to stop a few clocks and ring a few bells. The movement was apparently that of a pendulum, and its direction was from north to south. Two successive oscillations were observed separated by an interval of from three to four seconds, and each oscillation lasted from two to three seconds. The movement gained in intensity, as I have said, as it proceeded southwards, more especially after leaving the southern border of the central tableland limited by the fault of the valley of the Guadalquivir. Now, the interest of the phenomenon lies in the coincidence observable between its various manifestations and the geological structure of the peninsula. To make this clear, let me be permitted to offer a few observations on the subject of that geological structure. The archaic formations of the peninsula, with rare exceptions, lie in folds and faults running with singular consistency from south-west to north-east, and as an instance of this peculiarity I may mention the Carpathian range, which crosses the peninsula from east to west. After these archaic disturbances the Cambrian and Silurian deposits were likewise in their turn crumpled up into folds. These, however, run from north-west to south-east, that is to say, in a direction which forms almost a right angle to the earlier archaic folds. Concurrently with this general crumpling of the lower Palæozoic strata, there appeared in a broad zone great masses of granite, porphyry, diabase, and other kinds of rocks, which cross the peninsula from Galicia to the valley of the Guadalquivir, and which, geologically speaking, divides the peninsula into two distinct parts. This huge belt, which may be regarded as one of the most striking features of the peninsula of our day, cuts and divides the archaic formations, as this may be perceived at once in the central Carpathian range itself, which is interrupted between the Sierra de Gata and the Estrella range in Portugal. A study of the Mediterranean watershed of Andalusia will show the existence of two great mountain masses, chiefly formed of archaic deposits. One of these is known by the name of the Serrania de Ronda, and the other by that of the Sierra Nevada. Both run in a series of folds and faults from south-west to north-east, and between them there lies an interval filled up with palæozoic, secondary, and tertiary deposits. Towards the middle of this interval there rises up, like an island in the midst of these later deposits, a series of ridges running from north-west to south-east, and formed of archaic rocks. They are known by the name of the Sierra Tejea and Sierra Almijara, and the folds of these ranges, as in the case of the other archaic formations, run from south-west to north-east. It is clear, therefore, that this intermediary mountain mass is a segment of a more considerable archaic formation, separated from adjacent rocks through the subsidence of the ground on both sides. Owing to constant oscillations, this detached portion has been covered with the thick mantle of sediment which now overlays it, and its structure is easily accounted for as the result of that great fracture which crosses the peninsula from north-west to south-east, in the prolongation of which lies the region I am now describing. This fracture does not evidently end in the valley of the Guadalquivir, and though the surface be covered over by later deposits, it apparently extends to the country lying between the archaic mountain masses of the Serrania de Ronda and the Sierra Nevada, which it divides from one another, and whose ancient unity is testified by the Sierras Tejea and Almijara. The two principal coincidences observable between the phenomena of the earthquake and the geological structure of the peninsula are:—(1) That the disturbance of December 22 was confined to the regions lying to the west of the zone above described; and (2) that the most violent shocks of the earthquake of December 25 were experienced in the region intervening between the Sierra Nevada and the Serrania de Ronda, and precisely on the very belt which incloses the archaic mountain mass of the Sierras Tejea and Almijara. That part of Andalusia, broken and torn by the secular disturbances of our globe, has proved naturally the weakest, and has, therefore, been the most exposed to the shocks from which Andalusia has so terribly suffered. There stood Alhama, now prostrate in the river bed; there, Periana, a heap of ruins 3 m. high; there Albuñuelas, which exists no longer; there Zafarraya, Nerja, Torrox, and many other towns and villages; all testifying to the fragility of those faults, which though dating back to the Silurian period, are still apparently not completely welded.

MR. G. JOHNSTONE STONEY, F.R.S., Vice-President of the Royal Dublin Society, will give a discourse at the Royal Institution on Friday evening, February 6, on "How Thought presents itself in the Phenomena of Nature"; and on the following day (Saturday) he is to begin a course of three lectures upon the "Scale on which Nature works and the Character of some of her Operations." The following are the titles of the three lectures:—"Operations of Nature carried out on a Great Scale"; "Operations which go on between Molecules"; and "Operations which go on within Molecules, and the more Subtile Operations of Nature."

ACCORDING to *Science*, about 10 per cent. of the plants collected in the North-Western Mexican States by recent collectors prove to be new species.

MAY we suggest to the authorities of the British Museum the desirability of taking some means of letting the public interested in the matter know some little time beforehand when those lectures are to be delivered which are so regularly reported in the *Times*, but of the arrangements for which no one seems to know anything?

DR. J. A. FLEMING is about to give, at University College, Gower Street, a course of lectures on "Modern Applications of Electricity in the Arts." The lectures will be interspersed with practical demonstrations.

THE Electrical Exhibition, which was to take place at the Paris Observatory in the beginning of January, has been postponed to March 19.

THE thirty-eighth annual general meeting of the Institution of Mechanical Engineers will be on January 29 and 30, at 25, Great George Street, Westminster, by the kind permission of the Council of the Institution of Civil Engineers. The chair will be taken by the President at half past seven p.m. on each evening. The following reports and papers will be read and discussed, as far as time will admit:—Final report on experiments bearing upon the question of the condition in which carbon exists in steel, by Sir Frederick Abel, C.B., D.C.L., F.R.S.; second report of the research committee on friction; on recent improvements in wood-cutting machinery, by Mr. George Richards, of Manchester; on the history of paddle-wheel steam navigation, by Mr. Henry Sandham, of London; description of the Tower spherical engine, by Mr. R. Hammersley Heenan, of Manchester.

THE Dutch Government have issued the first part of their official report on the Krakatoa eruption. It deals with the history of the island prior to the occurrence, and the events of the catastrophe itself. The second part will deal with the scientific results of the investigation. The editor examined 1300 reports of eye-witnesses, and has endeavoured from them to construct a chronological statement of the events preceding and accompanying the eruption.

THE list of the conferences of the Sorbonne has been published for this year. On January 24 Dr. Brouardel lectures on the epidemics and protective measures; February 7, classification of celestial bodies according to their nature, by M. Faye; February 21, application of recent advances in physics to public works, by M. Gariel; March 14, architecture of the heavens, by M. Wolf; April 9, great volcanic catastrophes, by M. Velain.

WE are requested to state that Dr. William Pole, F.R.S., has been appointed Honorary Secretary of the Institution of Civil Engineers in the room of the late Mr. Charles Manby. The office of Secretary is filled, as formerly, by Mr. James Forrest. Mr. H. L. Antrobus has been re-appointed Treasurer.

MOST of the inhabitants of Leden, the *Standard* states, about a mile from Colchester, were awakened shortly after midnight on Sunday by what they believe to have been an earthquake. Much alarm was occasioned. The shock occurred at half-past twelve o'clock, and lasted about thirty seconds. The houses shook and the crockery rattled, but the shock was nothing like so severe as the one experienced last April. The shock seems to have extended as far north and east as Aldeburgh.

SEISMIC activity appears to have been exceedingly widespread recently. In the middle of November the first earthquake in ten years occurred at Monkden, in Manchuria. Both shocks, the present and one ten years ago, came from the same direction, viz. north-west to south-east, which, it is curious to note, is not the prevailing direction of the hill ranges, but at right angles to it. The Chinese in Manchuria are persuaded that warning of approaching earthquakes is given by the Coreans to the Chinese Government, and that the shaking of the earth is caused by the yawning of the great fish, on which the globe reposes.

IT is reported from Sundal and Öxendal, on the west coast of Norway, that a severe shock of earthquake was felt there at about 7 a.m. on December 28. The shock was so violent that the houses shook, and the people ran out terrified. It was impossible to tell in what direction the shock went. This phenomenon is remarkable for two reasons, viz. that it hardly ever occurs in Norway, and that it occurred on the day after the terrible earthquakes in Spain.

THE prospectus has been issued of the *American Journal of Archæology*. The Archæological Institute of America has recognised the *Journal* as its official organ. Among the specific objects of its editors will be:—(1) To afford to American scholars the means of taking active part in the progress of archæological science by the publication of papers embodying the results of original research; (2) To provide a careful and ample record of archæological discoveries and investigations in all parts of the world, and to furnish reports of the proceedings of archæological societies, summaries of important papers, reviews of books, &c.; (3) To bring to notice and to illustrate important works in the domain of archæology contained in our public museums and private collections, now little known. The following is a list of the editorial staff, so far as at present formed:—Advising Editor: Prof. Charles Eliot Norton, of Harvard College; Managing Editor: Dr. A. L. Frothingham, of Johns Hopkins University; Special Editors: Dr. A. Emerson, of Johns Hopkins University, Mr. T. W. Ludlow, of New York, Prof. Allan Marquand, of Princeton College, Mr. A. R. Marsh, of Harvard College, Mr. Charles C. Perkins, of Boston. The *Journal* will be published four times a year, and the numbers for each year will form an 8vo volume of about 360 pages. Messrs. Trübner and Co. will be the English agents.

AT Königsberg, in Prussia, will take place during the months of May to August of this year an International Industrial and Polytechnic Exhibition for machinery, motors, tools, appliances for mechanics, small manufacturers, &c. The following are some of the heads of groups under which exhibits will be classified—viz. (1) motors; (2) transmission appliances; (3) tools and implements for all branches of manufacture; (4) chemical and physical apparatus; (5) apparatus for technical education; (6) safety and protective appliances; (7) machinery and appliances for household purposes and for innkeepers; (8) agricultural implements and appliances. The Exhibition takes place under the authority of the Industrial Central Union of the province of East Prussia. Dr. N. Heinemann, of the new Athenæum Club, 3, Pall Mall East, has been appointed Special Commissioner of the Exhibition for England, and will give all necessary information to intending exhibitors.

THE annual meeting of the Association of Assistant Mistresses, which is confined to mistresses in girls' high schools, endowed, and proprietary schools, was held on Saturday at the North London Collegiate School for Girls. The President, Mrs. Hankin, of the Edgbaston High School, Birmingham, was in the chair. The discussion of the rules of the Association occupied a large proportion of the time. The Secretary's report showed that the work of the past year (the first of the Association's existence) had been chiefly that of organisation, whilst the Treasurer's report gave a hopeful account of the finances of the institution, there being a considerable balance in hand. It was resolved to appoint foreign and colonial correspondents, whose duty it should be to inform the Association of openings abroad, and a home correspondent, to whom assistant mistresses might apply, and to whom notices of vacancies might be sent. A plan for a lending library, to consist chiefly of voluntary loans of books, was approved, and a sub-committee was appointed to carry it into effect. A hope was expressed that publishers might be induced to present copies of educational works, and that any friends to the Association, leaving England for a time, might grant the use of their books during their absence. Mrs. Bryant, D.Sc., was elected President for the coming year. After the conclusion of business, the meeting proceeded to the discussion of papers on educational subjects. Miss Sharpe of Bradford read a paper on the training of teachers. Several papers were also read on the correction of exercises, describing the systems obtaining at different schools. It is from the discussion of such papers that the Association anticipates practical results: by their means, ideas are circulated that would otherwise remain unknown to the majority, and hints given by which all interested in their

work will profit. Papers on educational subjects will be read at the spring meeting, which is to take place in the middle of April at the Girls' Grammar School, Bradford.

OLD residents of the California peninsula have noticed several varieties of birds near the sea coast that they have never before known to leave the mountains. This is supposed to indicate a severe winter, but the migration is more probably due to the prevailing scarcity of all kinds of seeds in the mountains this season.

ACCORDING to the report of the captain of a vessel which in December returned from Eskefjord, on the east coast of Iceland, showers of ashes fell on Eastland early in November. The deck of the ship was covered with a thin layer of ashes, probably caused by a volcanic eruption inland.

MR. W. HEWITT, Science Demonstrator to the Liverpool School Board, writes to us with reference to the "Itinerant" method of science teaching. The special instruction is, in Liverpool, he states, commenced with the children in the *fourth* standard, and by this means deals with more than double the number of children who would be included were the commencement deferred until the fifth standard, as appears to be the case in Birmingham. There is every reason to believe, Mr. Hewitt thinks, that the preliminary instruction in the fourth standard is a very important part of the intellectual training which it is the object of the system as a whole to give. The stages of instruction in each subject are kept quite distinct throughout, and are always taken in the same order. The children on commencing the subject take up the first stage, and proceed in the following year to the second stage, and so on through a systematic and carefully-graduated three (or four) years' course of instruction in elementary science.

THE hatching of lobster and fish is making great progress in Norway. Thus, last year the Association for the Promotion of the Norwegian Fisheries hatched 7,000,000 fish, chiefly cod and haddock, at their establishment of Arendal, in the Christiania fjord, and this winter between 50,000,000 and 60,000,000 more will probably be turned out. The experiments, which were made of placing the ova of lobster in hatching apparatus, have been attended with great success, and show that they may be turned out by the million in this manner. As private enterprise cannot be expected to undertake these operations from year to year on a large scale all along the coast, the Association have petitioned for Government support, which will, it is expected, be readily forthcoming, as the Norwegians now clearly see of what enormous benefit to the nation these operations are.

MR. NEWALL asks us to state that in his note on "The *Jeannette* Drift" (vol. xxxi. p. 102), the word *knots* should be *nauts*, a *naut* being a geographical mile of 60 to a degree. It is a much more convenient measure than the mile of 1760 yards, for it contains 1000 fathoms, or ten cables of 100 fathoms each, as used in the navy. It is the only decimal measure used in any Government department! *Knot* is a mark on a line used on board ship, having the same proportion to a *naut* which a half-minute glass has to an hour, or the 1/120th part of a naut; so, when 10 knots pass out during one turn of the glass, the sailor means that the vessel is passing through the water at 10 nauts an hour.

THE additions to the Zoological Society's Gardens during the past week include a Golden Eagle (*Aquila chrysaetos*) from Sutherlandshire, presented by Col. E. D. Hunt; a Crossbill (*Loxia curvirostris*), British, presented by Mr. G. Skegg; seven Bramblings (*Fringilla montifringilla*), two Chaffinches (*Fringilla cælebs*), a Tree Sparrow (*Passer montana*), a Black-headed Bunting (*Emberiza melanocephala*) from Norfolk, presented by Mr. T. E. Gunn; a Nilotic Crocodile (*Crocodilus vulgaris*) from Africa, presented by Mr. H. E. Cree; a Brush-tailed Kangaroo (*Petrogale penicillata* ♂) from New South Wales, a Golden-crowned Conure (*Conurus aureus*) from South-East Brazil, deposited; two Striated Tanagers (*Tanagra striata*) from Buenos Ayres, two Siskins (*Chrysomitris spinus*), British, purchased; a Virginian Fox (*Urocyon virginianus*) from North America, received in exchange.

OUR ASTRONOMICAL COLUMN

COMETS OF SHORT PERIOD. (1) ENCKE'S COMET.—The following ephemeris of this comet for February is founded upon Dr. Backlund's elements, which the January observations show to be very exact:—

At 6h. Greenwich Mean Time

1885	R.A. h.	m.	s.	Decl. °	′	Log. distance from Earth	Sun
Feb. 1	23	33	0	+6	32·4		
2	—	34	31	6	38·6	0·0884	9·9279
3	—	36	3	6	44·7		
4	—	37	35	6	50·7		
5	—	39	8	6	56·4		
6	—	40	40	7	2·1	0·0705	9·8901
7	—	42	13	7	7·5		
8	—	43	45	7	12·7		
9	—	45	17	7	17·5		
10	—	46	49	7	21·9	0·0490	9·8478
11	—	48	20	7	25·8		
12	—	49	50	7	29·2		
13	—	51	18	7	31·9		
14	—	52	44	7	33·9	0·0233	9·8003
15	—	54	7	7	34·9		
16	—	55	26	7	34·9		
17	—	56	41	7	33·7		
18	—	57	52	7	31·1	9·9924	9·7470
19	—	58	57	7	26·9		
20	23	59	54	7	20·7		
21	0	0	42	7	12·4		
22	—	1	20	7	1·4	9·9555	9·6881
23	—	1	46	6	47·5		
24	—	1	57	6	30·1		
25	—	1	51	6	8·9		
26	—	1	25	5	43·2	9·9123	9·6263
27	0	0	36	5	12·4		
28	23	59	22	+4	35·9		

(2) BARNARD'S COMET.—Dr. Berberich, of Berlin, has made a new determination of the orbit of this comet from three normal positions deduced from observations extending over a period of three months. The sidereal revolution is now found to occupy 1958·9 days, or 5·363 years. In heliocentric longitude 343° 40′, the distance of the comet from the orbit of Mars is only 0·0079, and a revolution but slightly differing from that obtained by Dr. Berberich would have caused a very close approach of the two bodies as lately as the end of 1873 or beginning of 1874. The distance of the comet at aphelion from the orbit of Jupiter is 0·572. As previously remarked, much interest attaches to this comet from the similarity of the elements of its orbit to those of "the lost comet of De Vico," observed in the autumn of 1844.

(3) WOLF'S COMET.—Dr. Tempel, writing from Arcetri on the 4th inst., describes this comet as being still "sehr hell mit leicht zu beobachtendem Kerne." Considering that accurate observation commenced on September 20, the mean motion may be expected to be pretty exactly defined by the observations at this appearance, and the comet's orbit previous to the near approach to the planet Jupiter in 1875 may be investigated, with probability of a reliable result, without waiting for observations at its next return to perihelion in 1891.

GEOGRAPHICAL NOTES

THE *Bulletin de la Société de Géographie* for the last quarter of 1884 is largely occupied with the geography of the Far East. Two members of the foreign mission body communicate papers on Tonquin, both accompanied by maps. Père Pinabel writes on some "savage peoples" dependent on Tonquin. The expression "savage" is explained to mean nothing more than mountaineers. The tribes here described inhabit the mountains of the province of Thague-hoa, between the rivers Maa and Chou, which is the most southern province of the delta of the Red

River, and not far from the Annamite border. The tribes called Phon-tays, live in a sort of semi-independence, like the Laos tribes, in the mountains on the Siamese frontiers. A third tribe inhabiting the region is called by Père Pinabel the Méos (Moïs?), and are said by him to be in all probability the aboriginal Miao-tsze of South-Western China, although whether he has any ground for this belief beyond the resemblance of the names does not appear. At any rate, it is evident from their customs and language that they are Chinese. A fourth tribe is called the Sas, of whom nothing appears to be known except that it fled to the borders of Annam during one of the numerous wars of that region. A long and tolerably detailed account of the manners and customs of the Phon-tays is given, and shorter ones of those of the Moïs and Sas. They are all the more interesting that the writer appears to have no idea of ethnology, and therefore is not on the look-out for parallels elsewhere, but records everything with simplicity and directness. Père Blanck's experiences lay also in the Laos States, on the frontiers of Siam and Tonquin, but to the south of those of his colleague. His paper is simply a record of his journeys among the "savages" in the mountains between the province of Nghé-Ane, the most southern province of Tonquin bordering on Annam, and the Mei Kong River. Both these papers are taken from the reports of the *missions étrangères*. M. du Cailland describes the Quang-si, or Kwang-si, the province of China adjoining Tonquin, and that from which the greater part of the Chinese invading force is drawn. The writer discusses the routes from Langson into China, the river-system of Kwang-si, its administrative divisions, its ethnography, recent history, and the Catholic propaganda there. According to M. du Cailland, the Chinese population there is nothing more than a colony of Cantonese amongst the vast numbers of Miao-tsze and Laos in the western portion. Unfortunately, the writer has omitted his authorities for this statement, although his references in other portions of the paper are somewhat copious. It would be of great interest to learn on what grounds the wealthiest and most populous province but one of Southern China is believed to be only a Cantonese colony, while the Miao-tsze, who are generally believed to exist only in small and weak communities scattered over the central part of South-Western China, are masters of this vast district. The geography and ethnography of China must be rewritten, if M. du Cailland is accurate in this portion of his paper.—M. Huber continues his account of his journey in Central Arabia, which has been already noticed.—Prince Roland Bonaparte describes fourteen voyages to the coasts of New Guinea, made by Dutch Government vessels, between 1876 and 1883. They went chiefly from Ternate. Each voyage is described in detail, apparently from official sources. The conclusion of the paper is that it is easy to see from this account that the Dutch have annexed in a definite manner the eastern part of New Guinea to their empire in the Malay Archipelago.—M. Simonin discusses the progress of the Australian colonies commercially and politically.

AT the last meeting of the Gesellschaft für Erdkunde in Berlin (January 3) Dr. Steinmann read a paper on his journeys in Southern Patagonia. In 1882 he went as geological assistant to the fourth German expedition to Punta Arenas, mainly with the object of studying the Southern Cordilleras. What struck him particularly here was the extraordinary difference in the plant forms to those on the Southern Cordilleras, while on the western slopes vegetation is rich in forms, the climate of the steppes reigns on the eastern side. From a geological point of view, the southern point of America is extremely simple in its build, but it is of a different character on the east and west. On the east chalk formations occur almost entirely, while on the west, where there are innumerable islands, there is nothing but granite and crystalline rocks. Although the configuration of the coast has been studied thoroughly by the English, Dr. Steinmann thinks that many important questions have still to be settled; for instance, whether Laguna Blanca, lying to the north-east of the settlement Kyrsing Water, has an outlet to the west. Ultimately the lecturer reached the Laguna of the third settlement of Santa Cruz, of which it may with certainty be said that was connected until recently with the Pacific Ocean. It may also be concluded that at that time the mainland was much more cut up by channels and waterways than it is now. In May 1883 Dr. Steinmann visited, in the company of Fuegian seal-hunters, the islands south of the Straits of Magellan, including Tierra del Fuego. Ultimately, he made his way from the southern point of America to Bolivia, and here continued his investigations.

THE Society of Naturalists in St. Petersburg has received permission to despatch several of its members to join the Russian representatives on the Afghan Boundary Commission, with the view to the scientific exploration of Central Asia. The English Commission, which is now on the spot, has, it will be remembered, a geologist, a naturalist, and topographers amongst its number.

THE *Daily Telegraph* is publishing a series of articles descriptive of the Kilimanjaro expedition, "by its leader," Mr. H. H. Johnston. They are full of interesting detail.

WITH the commencement of the new year *L'Exploration* has taken a new form and a new title. It is now called *La Gazette géographique et l'Exploration*, and is about double its former size, the pages being larger and arranged in double columns. We trust that with this improvement there may be a corresponding advance in its usefulness as a geographical journal.

Petermann for January contains an article and map on the journey of the pundit A—— R—— in Eastern Thibet during the years 1878-82. Dr. Richard Lüddecke writes on the Italian emigration of 1883 from official sources. France takes nearly half of the emigration to European countries, while the State of La Plata and North America take the largest share of the extra-European emigration. Dr. Pauli writes on the Cameroons, and Herr Regel describes a journey from Charjui by Merv to Pandy, and back to Samarkand.

GEOLOGY OF AFGHANISTAN

THE *Times*, in the letter from its correspondent with the Afghan Boundary Commission, publishes the following notes supplied by Mr. Griesbach, of the Indian Geological Survey:—

"The hill ranges between Kushkak and Pahri in the Herat valley are all apparently composed of rocks belonging to the Cretaceous and younger periods. So far as I could judge, the ranges are formed by a series of parallel anticlinal folds of the Upper Cretaceous rocks, which in this part of Afghanistan (as in a great part of Persia) are hippuritic beds. They are mostly limestones, dark gray to white, and contain fossils in abundance, among which several species of hippurites are the commonest. The igneous rocks which play such an important part within the hippurite area in the Candahar district were also met with here under exactly the same conditions. Basic rocks (trap) are intimately connected with the Cretaceous limestones in this area also, and it would be impossible to distinguish them on anything but a very detailed geological map. Here also the limestone near the contact with the trap (and other igneous rocks) has been converted into a white, fine-grained marble, much used by the natives of Southern Afghanistan for monumental purposes. But by far the most interesting of the igneous rocks is a syenitic granite which appears in several patches. The Karez-i-Dasht is composed entirely of this rock, which is seen to be capped by trap in the surrounding hill ranges. Its age is most probably younger than that of the trap through which it has burst. This group of rocks, with the exception of patches of younger Tertiary rocks, form all the ranges up to and including part of the Chillingak range and pass (near Pahri). The latter range, in which the conspicuous Doshakh peaks are situated, is of great geological interest. It is an anticlinal fold, the centre and northern axis of which is formed by Palæozoic rocks; so far, I have only been able to detect Carboniferous fossils in a series of dark blue limestone beds, but it is quite possible that older groups are also there. The ravine leading to the high points south of Robat-i-Pai Ziarat has excavated its course through Carboniferous beds only. The beds dip north and below the younger gravels and fan deposits of the Heri Rud. But on the right bank of the valley, rocks appear again of an entirely different look, and it is quite possible that members of the lower Mesozoic system are represented there. The southern flank of the Chillingak range is formed only by Cretaceous beds—sandstones and shales of the Kojak type, overlaid with hippuritic limestone near Pahri. The connection of these beds with the Palæozoic strata of the centre is quite hidden. The older river deposits and Dasht beds are clays, sandstone, and conglomerates much of the same character as already described from the Helmund. They form thick deposits south of Pahri and in the Heri Rud Valley, and I have found remains of mammalian bones in them.

I believe them to belong to the upper beds of the Siwalik series. In connection with the notes which I was enabled to make during the very hasty examination of the ground travelled over, two facts seem to me to be of considerable importance. The first is the reappearance of older strata than Cretaceous, and strata of distinctly a Himalayan type. One of the great problems of Asiatic stratigraphy is the exact connection of the sedimentary rocks of the North-West Himalayas with the system of the Caucasus, which is again only a continuation of the Alpine system; whether or not the Hindoo Koosh may be looked upon as a continuation of our North-West Himalayas can only be decided after an examination of its geotectonic features. The connecting link, so to speak, has yet to be found. But the finding of true Carboniferous marine beds containing *Productus semireticulatus* in a range which belongs to the Hindoo Koosh system is a distinct step towards the solving of the great stratigraphical problem of Central Asia. The second fact is of rather an economic than purely scientific interest. I found at more than one place along the route an altered rock near the contact of the hippuritic limestone and the igneous rocks, which in character resembles exactly the gangue in which at Candahar the gold and other minerals occur. So I believe that a careful search would certainly reveal similar ore-deposits in the Sabzawar and Herat districts. I may here mention again that the contact rocks in the Candahar district contain exactly the same minerals as do the altered hippuritic limestone beds of the Banat in Hungary, which also have been disturbed by young granitic rocks."

The same Correspondent, in a previous letter, describes the journey across Seistan from Khwaja Ali to Lash Jowan. The geological features of this part of Seistan are, according to Mr. Griesbach, extremely simple. Only post-tertiary and recent deposits were met with; the former are fluviatile beds, mostly clays, soft sandstones, and gravels, in character much the same as those forming the tableland of Handesin Tibet, and probably belonging to the same age. The drainage of the area during post-tertiary times seems to have been generally identical with the present one, though, perhaps, of a more extended nature. The recent gravel beds and conglomerates containing worn material from the neighbouring hill ranges are found in the Farah Rud and the Kash Rudak in considerable thickness, capping the underlying clays and sandstones of post-tertiary age. Locally, the conglomerate is replaced by a hard limestone breccia, as for instance at Galichah and also the Helmund. But the general character of this deposit is that of the Indus valley gravels, which are seen to overlie unconformably the younger Siwaliks along the Marri and Bugti hills and the Suliman range. They are found of course within the area of the present drainage. Of useful minerals, only gypsum exists, which is found in the post-tertiary clays, fills fissures and joints, and may perhaps also be found in larger masses. Apparently it is made use of for the manufacture of Gutch or plaster; traces of diggings for it are found near Lash.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The following scheme of lectures and classes in Natural Science has been issued by the Faculty for Lent Term, 1885:—

In the Physical Department of the Museum Prof. Clifton continues his course on the Galvanometer and Ohm's Law. Practical instruction in Physics is given by the Professor and by Messrs. Walker and Selby. Mr. Walker lectures on the Theory of Errors, and Mr. Selby, on Elementary Mechanics. At Christchurch Mr. Baynes lectures on Electrodynamics, and has a class for practical instruction in Electrical Measurements. At Balliol Mr. Dixon lectures on Elementary Magnetism and Electricity.

In the Chemical Department of the Museum Dr. Odling continues his course on the Adipic Compounds. Mr. Fisher lectures on Inorganic, and Dr. Watts on Organic, Chemistry. At Christchurch Mr. Harcourt lectures on the Non-Metallic Elements, and at University Mr. Veley lectures on Physical Chemistry.

In the Morphological Department of the Museum Prof. Moseley continues his course on the Comparative Anatomy of the Invertebrata. After each lecture special instruction is given in illustration of the lecture. Dr. Hickson lectures on Animal Morphology, Mr. Barclay-Thompson on the Anatomy of Mammalia, Mr. Hatchett Jackson on the Principles of Comparative Embryology and Development, and Mr. Poulton on the Distribution of Animals.

In the Physiological Department of the Museum Prof. Burdon-Sanderson lectures on the Nervous System, and practical instruction is given by the Professor and Messrs. Dixey and Gotch.

In the Botanic Garden Prof. Bayley Balfour lectures on Elementary Morphology and Physiology, and on the Morphology of the Vascular Cryptogams. Prof. Gilbert lectures on the Result of Field Experiments.

Dr. Tylor lectures on the Early History of Arts and Sciences; Prof. Maskelyne on the Rectangular-axed Crystal Systems; Prof. Prestwich on the Palæozoic and Mesozoic Series.

It is rumoured that the grant to carry on the new physiological laboratory under Prof. Burdon-Sanderson will be opposed in Convocation by the anti-vivisectionists. If this should turn out to be true, it behoves all members of Convocation who side with the advancement of science to come up and record their votes.

CAMBRIDGE.—The Board for Physics and Chemistry announces the following lectures for this term:—

Chemistry: Prof. Liveing, General Course; Prof. Dewar, Organic Chemistry; Mr. Main, St. John's, General Course; Mr. Pattison Muir, Caius, General Principles, advanced, especially Physical Chemistry; and Elementary Course for 1st M.B.; Mr. Scott (Prof. Dewar's assistant) Elementary Organic Chemistry; Mr. Heycock, King's, Chemical Philosophy for Tripos, Part I.; Practical Chemistry, Mr. Sell and Mr. Fenton, three courses of demonstrations, for medical students, Tripos Part I. and Tripos Part II.; Mr. Robinson, Chemistry as applied to Agriculture; Sidney College Laboratory, Demonstrations for 1st M.B., with explanatory lectures.

Physics: Prof. Stokes, Hydrodynamics; Prof. Thomson, Magnetism; Mr. Atkinson, Trinity Hall, Heat and Hydrostatics; Mr. Glazebrook and Mr. Shaw, Elementary and Advanced Physics; Mr. Hart, St. John's, Light and Electricity, elementary and advanced; Practical Physics, Demonstrations in Cavendish Laboratory, three courses.

Mineralogy: Prof. Lewis, Lectures and Demonstrations.

Mechanism: Prof. Stuart, Mechanism and Applied Mechanics, and Theory of Structures; Mr. Lyon, Elementary Mathematics, and Statics and Dynamics.

The Board for Biology and Geology publish the following list of lectures:—

Geology: Prof. Hughes, Pleistocene, with special reference to Prehistoric Archæology; Dr. R. D. Roberts, Physiography, and Class Work; Mr. Marr, Geological Evolution; Mr. T. Roberts, Palæontology; Mr. Teall, Advanced Petrology; Mr. Harker, Elementary Petrology and Class Work; Prof. Hughes, Field Lectures.

Botany: Dr. Vines, General Elementary Course, with practical work; Mr. Gardiner, Anatomy of Plants, advanced, with practical work; Dr. F. Darwin, General Biology of Plants; Mr. J. W. Hicks Sidney, Elementary Course; Mr. Potter, Classification of Gymnosperms and Monocotyledons.

Elementary Biology: Dr. Vines and Mr. Sedgwick.

Zoology: Prof. Newton, Geographical Distribution of Vertebrata; Mr. Weldon, Practical Morphology, Invertebrata; Mr. Sedgwick, Anatomy and Embryology of Vertebrata, elementary; Mr. Harmer, Osteology of Vertebrata, and advanced course on Arthropoda; Mr. Gadon, Palæontology and Affinities of Groups of Mammalia.

Physiology: Prof. Foster, Elementary Course; Mr. Lea, Chemical Physiology; Mr. Langley, Advanced Course; Dr. Gaskell, Circulation and Respiration, advanced; Mr. Hill, Class for 2nd M.B.

Human Anatomy: Prof. Macalister, Organs of Circulation and Respiration; Demonstrations in Osteology.

The Board for Mathematics announces the following lectures on higher mathematics this term:—Prof. Stokes, Hydrodynamics; Prof. Adams, Lunar Theory; Prof. Thomson, Trinity College, Electromagnetism; Mr. Hobson, Christ's, Planetary Theory; Mr. Glazebrook, Theory of Light; Mr. Forsyth, Functions of Complex Variables; Dr. Besant, Analysis, Definite Integrals, Calculus of Variations and Differential Equations; Mr. Mollison, Fourier's Series and Conduction of Heat; Mr. Pendlebury, Analytical Optics; Dr. Routh, Attractions and the Figure of the Earth; Mr. Stearn, Electrostatics.

Mr. G. J. Romanes, LL.D., F.R.S., has been appointed to deliver the Rede Lecture this year.

R. E. Fry, Clifton College, has been elected to a Natural Science Open Exhibition at King's; W. J. Elliott, Newcastle

School, Staffs., and A. E. Potter, Yorkshire College of Science, to Entrance Scholarships at Christ's College; H. Bury, third year, and F. W. Oliver, second year, to Foundation Scholarships at Trinity College.

S. F. Dufton, Grammar School, Bradford, has been elected to an Open Exhibition for Natural Science at Trinity College, and A. E. Mayeur, St. Paul's, to an additional Exhibition.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, 708, December, 1884.—G. Forbes, dynamo-electric machinery; a full report of the lecture given by Prof. Forbes at the Philadelphia Exhibition.—R. H. Thurston, steam boilers as magazines of explosive energy. This paper contains lengthy numerical tables of the energy, expressed both in foot-pounds and in kilogrammetres, stored up in boilers containing given weight of water or steam at given pressures. According to these calculations a Lancashire two-flue boiler holding three tons of water working at 37 lbs. of steam pressure would, by its explosion, liberate sufficient energy to blow itself nearly $2\frac{1}{2}$ miles high, with an initial velocity of 900 feet per second.—E. J. Houston, glimpses of the International Electrical Exhibition, Nos. 2 and 3. These papers give accounts of Dolbear's electrostatic system of telephony, and of Gray's telephonic inventions, with numerous illustrations.—L. d'Auria, the earth's ellipticity; a reply to Prof. Chase.—Standard sizes of belt heads and nuts, a reply by Mr. Coleman Sellers to Mr. Simmonds.

SOCIETIES AND ACADEMIES

London

Royal Society, Nov. 27, 1884.—"Notes on the Microscopic Structure of some Rocks from the Andes of Ecuador, collected by E. Whymper. No. V. (conclusion). Altar, Illiniza, Sincholagua, Cotocachi, Sara-urcu, &c." By Prof. T. G. Bonney, D.Sc., F.R.S.

The microscopic structure of rocks from the first four of these mountains was described, the specimens being less numerous than in some of the former cases. Altar, Sincholagua, and Cotocachi furnished augite-andesites, mostly hyperstheniferous; Illiniza, micaceous and hornblendic augite-andesites. Sara-urcu was not a volcanic mountain, the specimens all being metamorphic rocks, varieties of gneiss and schists, similar to those which occur among the less ancient metamorphic rocks of the Alps and the Scotch Highlands; hence, probably, Archæan, but not the very oldest Archæan. A few miscellaneous specimens were also described, and the paper concluded with some general remarks and a summary of results.

January 15.—"On the Chemical Composition of the Cartilage occurring in certain Invertebrate Animals." By W. D. Halliburton, M.D., B.Sc. (Lond.), Sharpey Physiological Scholar, University College, London. Communicated by Prof. E. A. Schäfer, F.R.S. (from the Physiological Laboratory, University College, London).

At Prof. Lankester's suggestion I have submitted to chemical analysis the cartilages occurring in Sepia and in Limulus.

The basis of the cartilage is a chondrin-like body which gives the reactions of mucin and gelatin (indeed, chondrin, as it occurs in the ordinary hyaline cartilage of Vertebrates, is now regarded by many as a mechanical mixture of these two bodies). But in the cartilages of the two Invertebrates in question the gelatinous element is exceedingly small, and no gelatinisation occurs on the cooling of the hot watery extract.

In addition to this, however, the cartilage of both these animals differs from that of Vertebrates in containing a certain small percentage of chitin. In the case of Limulus 1·01 per cent., and of Sepia 1·22 per cent., of chitin, in the dry state is present.

I have also demonstrated that chitin exists in the liver of the king crab, though whether in the connective tissue or in the liver cells themselves I cannot say. (The connective tissue element is very abundant in the liver of this animal, and it seems probable, looking at the part that chitin plays as a supporting structure in these animals, that it really forms in this instance a partial basis for the connective tissue.)

The way in which chitin was demonstrated to exist was the same in all three cases, viz.:—

(1) After digesting with potash, a residue insoluble in boiling alkalies remains behind.

(2) This residue, which, when washed and dried, is obtainable in a white amorphous condition, is insoluble in weak acids; but in concentrated mineral acids it is soluble in the cold.

(3) On boiling the solution in sulphuric acid, a body which has the power of reducing cupric salts is formed.

(4) On boiling the solution in hydrochloric acid it turns brown, and on evaporating this solution to dryness a body crystallises out which has all the properties of hydrochlorate of glycosamine.

(I prepared some of this body from the chitin contained in the exoskeleton of cockroaches, and also obtained from Prof. Lankester some crystals of the same body which Prof. Gamgee had kindly sent him.)

I was (thus) enabled to compare the crystalline body I had obtained from the invertebrate cartilage with that of the pure hydrochlorate of glycosamine, and they were found to agree in the following points:—

(*a*) Crystalline form: rhombic prisms of the monoclinic system; measurement of the angles gave the same result in all cases.

(*b*) Action of polarised light: *nil*.

(*c*) Solubilities: easily soluble in water, soluble with difficulty in alcohol.

These results are especially interesting as showing that chitin is not a body which is exclusively epiblastic in origin, but in these three instances at least occurs in mesoblastic structures.

Mathematical Society, January 8.—J. W. L. Glaisher, F.R.S., President, in the chair.—Messrs. F. R. Barrell, S. O. Roberts, and Prof. M. N. Dutt, St. Stephen's College, Delhi, were elected members. The Rev. T. C. Simmons was admitted into the Society.—Prof. M. J. M. Hill read a paper on the differential equations of cylindrical and annular vortices.—The Rev. R. Harley, F.R.S., spoke on criticoids.—The following further communications were made:—Multiplication of symmetric functions, by Capt. Macmahon, R.A.—Note on symmetrical determinants, by A. Buchheim.—Results in elliptic functions, by the President (J. J. Walker, F.R.S., Vice-President, in the chair).—Mr. Tucker read a second note by Prof. Cayley, F.R.S., on the binomial equation $x^p - 1 = 0$: quinquisection, and communicated a second paper, by H. MacColl, on the limits of multiple integrals.

Victoria Institute, January 19.—A paper on the historical evidences of the Abramic migration was read by Mr. W. Boscawen, in which he gave extracts from the new translations of some tablets which had been discovered by Mr. Rassam during his last visit to the East. These extracts contained a large number of names of persons and cities mentioned in the Bible record of the times to which they referred.

Edinburgh

Royal Society, January 5.—E. Sang, LL.D., Vice-President, in the chair.—Mr. Harvey Gibson submitted a paper on the anatomy of *Patella vulgata*.—Mr. W. W. J. Nicol read a paper on a theory of solution. Solution of a salt in a liquid results from the attraction of the molecules of the liquid for a molecule of the salt exceeding the attraction of the molecules of salt for one another. Saturation ensues when these attractions are balanced. The theory explains variation of solubility with rise of temperature. Mr. Nicol brought forward experimental evidence in support of his views.—Mr. H. R. Mill, chemist to the Granton Marine Station, read a paper on the salinity of the water of the Firth of Forth. Results were given, showing the variation of salinity along the Firth for high and low water.

Paris

Academy of Sciences, January 12.—M. Bouley, President, in the chair.—Thermo chemical experiments with phosphorous fluoride, a new gas recently discovered by M. Moissan, by M. Berthelot.—Anatomical description of *Ganidia Garnotii*, Payrandeau, a species of Ganidia very abundant on the coast of Algeria, by M. de Lacaze-Duthiers.—Report on M. Luvini's two memoirs dealing with the formation of hailstones and the development of electricity during thunderstorms, by the Commissioners, MM. Becquerel and Faye.—On the formation of toxic alkaloids in cholera patients, by M. A. Villiers. Experiments made on two victims of cholera soon after death enabled the author to determine the presence of an alkaloid clearly characterised by its alkaline and chemical reactions. It is found chiefly in the intestine, and also in small quantities

in the region of the loins, but is completely absent from the blood and liver. Its study may yield important results for the treatment of cholera, and must possess great interest for toxologists.—Observations of Encke's comet made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—Note on the theory of periodic transformations, by M. S. Kantor.—On some partially-derived linear equations of the second order, by M. Lucien Levy.—On the simultaneous effects of rotatory force and of double refraction, by M. Gouy. The author finds that these effects are in every respect conformable to those resulting from the hypothesis of Airy, that they may be completed by determining the values of K and δ, and generalised by extending them to other mediums besides quartz.—Action of boric acid on some coloured reagents, by M. A. Joly.—On the hydrates of the sesquichloride of chromium, by M. L. Godefroy.—On the alkaline ferrocyanates and their combinations with the chlorohydrate of ammoniac, by MM. A. Etard and G. Bemont.—On a combination of acetic ether and the chloride of calcium, by M. J. Allain-Le Canu. An analysis is here given of this compound, which was first indicated by Liebig.—On three new compounds of iridium, yielded by the combination of the perchloride of iridium, $IrCl_4$, with the hydrochlorates of mono-, di-, and trimethylamine, and corresponding in their composition to the chloro-iridate of ammoniac, by M. C. Vincent.—On various haloid derivatives from substitutes of propionic acid: chloruretted and ioduretted derivatives, by M. L. Henry.—On the significance of the polarimetric experiments made with the solution of cotton in Schweizer's liquid, by M. A. Béchamp.—On the influence of sunshine on the vitality of the germs of microbes, by M. E. Duclaux. From experiments made with *Tyrothrix scaber*, cultivated in milk and Liebig's extract, the author finds that the light of the sun is fifty times more destructive than its heat, and its hygienic properties are thus fully confirmed.—Studies on the head and mouth of the larvæ of insects, by M. A. Barthélemy.—On some points in the anatomy of the Cidaridæ of the genus Dorocidaris, by M. Prouho.—On a marine Hemiptera, *Æpophilus Bonnarei*, Signaret, by M. R. Koehler.—On a veinous cirrhosis determined in the rabbit by *Cysticercus pisiformis* (Auct.), and in connection therewith on the embolic origin of certain gigantic cellules, by M. Laulanié.—On a disease of the carob plant causing hypertrophy of certain parts analogous to the so-called malady of "la loupe" in the olive, by M. L. Savastano.—On the actual value of the magnetic elements at the Observatory of the Parc Saint-Maur, by M. Th. Mourceau.—On the earthquakes that occurred in Andalusia on December 25, 1884, and the following weeks, by M. Macpherson, with remarks by M. Daubrée.—On the ascending movement observed in certain waterspouts, by M. E. Vibert.

BERLIN

Meteorological Society, December 2, 1884.—Dr. Lœwenherz, after briefly sketching the history of the invention of the thermometer and the early improvements made on it, showed a large number of different constructions of the column and the inclosure thermometer for meteorological purposes, comprising the common as well as the maximum and minimum thermometer, and, in concluding his address, discussed the production of thermometers, the successive stages of which he illustrated by bringing forward glasses connected respectively with these.—Dr. Vettin spoke on the observations of clouds, and described an apparatus for measuring their height. Suppose the cloud projected to a distance of four miles, it then possessed at that distance a "projected" speed, in its actual height it possessed the actual speed, and from these two data the actual height could be calculated according to the proportion; the projected height H is to the actual height h as the projected speed C is to the actual speed c. The actual speed was measured by Dr. Vettin from the movement of the shadows of clouds, which he could in most cases determine directly by means of the sharp edges of the shadows cast on a large field of vision, where the objects and their distance from each other were known to him. In the case of cirrus clouds, again, the wandering of the darker and brighter spots along a street could mostly be determined likewise with the help of a time piece. For the purpose of determining the projected speed, Dr. Vettin made use of a special apparatus, a longish *camera obscura*, containing a lens which projected the image of the cloud on an inclined mirror, which in turn reflected the image on a dim glass plate at the side of the apparatus. This plate was round, and had scratched into it at its periphery a circular division, at which the movement of the cloud-image from the centre towards the periphery along a determined radius was measured. From the observed time and the inclination of the apparatus, with the help of tables calculated by Dr. Vettin, the projected speed could readily be found. Another method of measuring the height of clouds consisted in determining the angle of the last ray after sunset, or the first ray before sunrise, falling on a definite point of the cloud formed with the horizon. Besides the tables referred to in the first method described, Dr. Vettin had drawn up tables for ascertaining this angle from the observed time and for calculating the height of the observed cloud-point.—In accordance with earlier data adduced by Dr. Vettin, Prof. Boernstein showed two experiments which brought into beautiful exhibition the process by which ascending whirling currents of air were generated. A glass plate, on which stood a high glass bell, was covered with a layer of tobacco-smoke, which was heated from below by a small flame applied near the centre. At once arose an upright column of smoke, which broadened at the top and recurved outwards and downwards so as to form a beautiful whirl. In the second experiment a closed glass case was set on a rotatory apparatus capable of imparting to it a revolution such as the earth possessed on the northern hemisphere, or the reverse. The bottom of the glass case was warmed at a place of circumscribed area, from which arose a softly-ascending current of air analogous to that of the first experiment. If the case were now put in uniform rotation, and if, by means of a tube running through the lid down to the bottom of the case, tobacco-smoke were blown into it, so soon as the smoke came in contact with the heated place, a whirl was formed, and the smoke mounted upwards in the shape of a spiral, which, under a rotation of the case similar to that of the northern hemisphere, was in a direction opposed to the rotation of the hands of a clock. On the other hand, if the case rotated in a manner corresponding with the rotation of the southern hemisphere of the earth, the whirl of tobacco-smoke and the ascending spiral rotated in the direction of the hands of a clock. These simple and very instructive experiments may easily be performed if too much smoke be not admitted into the closed space and if the part heated at the bottom of the case be restricted to little more than a mere point.

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